NATURE

No. 4140 SATURDAY, MARCH 5, 1949 Vol. 163

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DEVELOPMENT OF BACKWARD TROPICAL REGIONS

IN a memorandum issued with the first report of the Select Committee on Estimates for the session 1948–49*, the Colonial Office replies to some earlier criticisms by the Committee suggesting that there was no coherent strategy of economic planning in the schemes for Colonial development which had been put forward. The Colonial Office in its reply refers to an unpublished memorandum of April 1944 on "The Planning of Social and Economic Development in the Colonial Governments", which states that the two primary objectives of British Colonial policy are the promotion of the best development of the social and political institutions of Colonial peoples, and of their true welfare in the widest sense. The memorandum assumes that the planning of developments to be undertaken in the Colonies would be 'outline' planning in the sense of providing a general framework while leaving a more or less substantial residue of decisions about production and consumption to private planning or individual initiative. On this interpretation of planning, in which strategy is defined as the selection of objectives and the marshalling of the forces necessary to reach those objectives, the Colonial Office submits that there has been a perfectly coherent strategy. The reply goes on to point out that from the beginning it was made clear that the ten-year 'developments' were not to be imposed from Whitehall, but were to be the creation of Colonial Governments and indeed of Colonial peoples themselves. The execution of the plans and the tactics employed are then defended, but in a way which is not altogether convincing.

There is, perhaps, less difference between the Colonial Office and the Select Committee on Estimates than the Colonial Office is disposed to admit. Far more stress was laid by the Select Committee on the necessity of associating the Colonial peoples with development plans at an early stage than would appear from this reply. The Colonial Office indicates the difficulties in co-ordinating the planning of developments in forty-five separate territories; but it never really answers the fundamental criticism that early information on the acute shortages of equipment, materials and man-power, which have brought certain schemes into acute competition for capital equipment required urgently for European reconstruction and development, could only have come from Whitehall. In the field of capital equipment it would seem that a case can be made for criticism. The Select Committee recommended that schemes of Colonial economic development requiring equipment in short supply should be framed in consultation with a planning authority in the United Kingdom having responsibility for allocation among home needs, export demands and all forms of Colonial development. This recommendation the Colonial Office regards as impracticable; but it recognizes the importance of the considerations on which the

* First Report from the Select Committee on Estimates. Session 1948–49. (London: H.M. Stationery Office, 1948.) 9d. net.

recommendation is based and is attempting to meet the need in other ways. Other recommendations of the Select Committee, it is stated, have already been adopted.

Despite this rather heavy-handed reply, it would appear that the criticism of the Select Committee has not been wide of the mark and has had an effect. Moreover, it is obvious from recent discussions on the progress of the groundnut scheme in Tanganyika that the bearing of the general criticism of the Select Committee on the operations of the Overseas Food Corporation has not escaped notice. It has at least strengthened the hands of those who are pressing for information both on the progress of the groundnut scheme and for parliamentary discussion on the activities of the Corporation. President Truman's recent proposal for American participation in the development of backward areas adds a further powerful reason for full public discussion of all the issues involved in Colonial development.

That there is much of scientific interest in such discussion requires no stressing. Thus, Mr. A. J. Wakefield read a paper on the groundnut scheme in East Africa before Section D (Zoology) at the British Association meeting at Brighton in which he emphasized the long-term character of the project and the way in which it is associated with questions of the production of other crops; he showed that it calls for the services of agronomists, soil chemists and surveyors, entomologists, pathologists, plant breeders, biochemists and others. At the same meeting, Sir Frank Stockdale stressed biological aspects of Colonial development, while the contribution of the scientific worker to human welfare in the Colonial territories was also brought out in the addresses of Lord Rennell of Rodd and of Dr. E. Scott Robertson, as well as in a specific discussion on scientific aspects of Colonial development before Section E (Geography).

Since that meeting, the publication of the four reports prepared for the Tsetse Fly and Trypanosomiasis Committee, reviewed by Sir Philip Manson-Bahr in these columns (*Nature*, January 22, p. 118), have demonstrated the thoroughness with which the task of survey and control of trypanosomiasis in Central Africa is being carried out and its bearing on Colonial development as well as health and welfare. The announcement of the new drug 'Antrycide' indicates the way in which scientific and industrial research in Britain is continually providing the medical and veterinary worker, the protozoologist and entomologist with new weapons, and opening up fresh prospects of controlling the major diseases and pests that ravage human and animal life and limit development in tropical areas. Some of these possibilities have no doubt been considered by the International Scientific Committee for Trypanosomiasis Research which met in London on February 8. This non-government standing committee of scientific men from the United Kingdom and the Colonies, France, Belgium, Portugal, South Africa, Southern Rhodesia and the Sudan, was formed as a result of the international conference held at Brazzaville in French Equatorial Africa in February 1948.

An important section of the report of the Commission of Enquiry into the Swollen Shoot Disease of Cacao in the Gold Coast not only praised the work of the West Africa Cacao Research Institute as basic to the maintenance of the cocoa industry in the Gold Coast, but also suggested an extension of research involving a considerable increase in both the facilities and staff at the Institute. It will also be recalled that in launching the groundnut scheme, the Government expressed the belief that its long-term importance might lie less in increasing the supply of fats for Britain and the rest of Europe than in its practical demonstration of the improved productivity, health, social welfare and prosperity which scientific agriculture can bring to Africa. In a recent address to the Manchester Statistical Society, urging the need for more capital for the Colonies, Prof. Arthur Lewis emphasized that more than this is required. The fundamental needs in all colonies are, in fact, the same. Apart from greater capital investment, the people must learn the laws of good husbandry. Proper cultivation, protection against erosion, the planting and felling of trees, selective breeding of livestock and irrigation where possible are fundamental in the development of every Colony. Behind all lies the need for further research in tropical agriculture: research into plant diseases and fertilizers, the breeding of immune varieties, methods of conserving water, the elimination of pests and the preservation of animal health.

The demands that are thus made on the Colonial Powers may well absorb all the surplus resources of Western Europe for years to come, and indeed a large part of those of the rest of the industrial countries of the world. This demonstrates the immediate significance of President Truman's proposal. This proposal would appear to accept and endorse the recognized basis of British Colonial policy, namely, that the development of the backward areas can only be achieved with outside technical and scientific assistance and large capital investment which must be carefully watched and controlled to avoid exploitation; and it offers to put the vast resources of the United States behind a great effort to carry out such a policy throughout all the under-developed areas of the world. Such association in itself may well prevent misunderstandings, which may sometimes arise when economic development appears to clash with the advance towards full self-government, and so forestall misrepresentation. The announcement that the Economic Co-operation Administration has approved the British Government's proposal for the augmentation of the Colonial Surveys by about fifty trained American workers, whose salaries would be met by that Administration, is a welcome sign of the beginning of such co-operation.

Research and education must, indeed, precede capital development, and it is a task which Great Britain at present finds peculiarly difficult, owing to its straitened resources of scientific man-power, to discharge adequately even within the Colonial Empire. It may well be hoped, therefore, that one effect of Mr. Truman's proposal may be so to implement both the Fulbright Act, which provides for sending

Americans to study, teach and engage in research abroad and for the cost of travel of nationals of other countries who wish to visit the United States for similar reasons, and also the Smith – Mundt Act of January 1948 for the establishment of an educational exchange service. An agreement between the Governments of the United Kingdom and the United States to put the Fulbright Act into effect was signed on September 22, 1948, but in the present currency situation the chief beneficiaries will be Americans. If, in view of the President's proposal, Congress now makes the necessary appropriations under the Smith – Mundt Act for international co-operation in the interchange of persons, knowledge and skills, the rendering of technical and other services and the interchange of developments in the field of education, the arts and the sciences, the purpose of the Fulbright Act may still be achieved.

Meanwhile, it is worth noting that the Colonial Office has now begun to issue a *Journal of African Administration*, one of the aims of which is to serve as a link between research and administration; the first issue refers to contacts which are being developed between the Colonial Office and the appropriate departments and institutions of foreign Colonial Powers. Here is further encouragement for men of science working in fields touching on human welfare, health and agricultural development, who have already recognized how much international co-operation can do to make their efforts fully effective in areas such as tropical Africa. President Truman's proposal is rightly linked with the European recovery programme and the firm establishment of world order; but there are few fields in which Anglo-American co-operation, the pooling of knowledge and scientific and technical resources and the interchange of staff, could contribute more quickly and richly to human welfare and social advance throughout the world than in the development and education of the backward areas of the world.

TAXONOMY OF THE HAWKWEEDS

A Prodromus of the British *Hieracia*

By H. W. Pugsley. (Journal of the Linnean Society of London, Botany, Vol. 54.) Pp. iv+356+17 plates. (London: Linnean Society, 1948.) 60*s*.

THE hawkweeds have long been known as a group of plants presenting peculiar difficulties to taxonomists. The general facts can be simply stated: in most parts of the generic range the hawkweeds are more or less locally limited entities which morphologically differ definitely, but not greatly, from other entities. These microspecies, or whatever they be called, come true in their differential characters from seed. In the British Isles, the northern and western parts are richest in *Hieracia*, and in the past their study has attracted many British botanists. The late Mr. H. W. Pugsley published "Notes on British Hawkweeds" in 1920, so that it is safe to say that the present prodromus is the result of more than a quarter of a century's investigations.

Within the limits of a 'micro-taxonomical' subject the work is in many ways excellently done. The descriptions are clear, sufficiently full yet concise, and easily comparable one with another. There is judicious citation of specimens and localities. The history of the classification of British *Hieracia* is adequately considered, and there is an interesting section on their morphology.

A conspectus of accepted species classifies these into sections and series; but it is unfortunate that no artificial key is provided to the latter. The greater part of the prodromus consists of descriptions with keys to the 260 groups recognized as species, the keys being generally placed under the series into which the species are classified. A considerable number of such species are here described and named for the first time. Under some of the species varieties are accepted. There is an index to the species and subsidiary groups, and seventeen plates show plants in black-and-white outline.

Various questions arise in perusing this volume. Modern research has shown that many *Hieracia* are apomictic—they set seeds without fertilization. Much of this cytological research has been done in Scandinavia, and apparently British hawkweeds have not been examined for their chromosomes or the absence of fertilization. There is, however, very little doubt that the entities accepted by Pugsley as species are apomicts (or groups of apomicts). Genetically, apomicts are the equivalent of clones. Unlike clones that are propagated, as clones, only by vegetative means, they spread by seeds which reproduce the clone. With these peculiarities there are good arguments for maintaining that apomicts should be taxonomically treated neither as species nor as varieties, but should be classified as distinct categories. It is to be regretted that Mr. Pugsley did not explain clearly the general principles by which he determined which of the presumably apomictic entities should be considered 'species' and which 'varieties'.

Another matter that may be disputed is his treatment of the part played, in the more or less long distant past, by hybridization. On this matter his statements appear to be confused. If *Hieracia* be completely apomictic, at the present day, hybridization cannot occur between the apomicts; but this does not mean that hybridization did not occur when amphimixis was the rule in the genus. Indeed, some cytologists have held strongly that hybridization is an important cause of apomixis.

W. B. TURRILL

THE SPECIES OF MODERN MAN

Human Ancestry from a Genetical Point of View

By Professor R. Ruggles Gates. Pp. xvi+422+27 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1948.) 42*s*. net.

THE subdivision of modern man into distinct species rather than into "races" is justified in the first instance, says Prof. R. Ruggles Gates in his new book, on the score of "convenience" (p. 11). "Consistency in nomenclature and methods of classification necessitate the recognition of several species of living man", he adds (p. 406). Like Prof. Ruggles Gates, anthropologists well appreciate the difficulty of distinguishing (except arbitrarily) clear-

cut races of mankind and of specifying the criteria by which they are to be recognized. Indeed, at the recent International Anthropological Congress at Brussels the complexity of the problem received fresh affirmation. One might have hoped then that the first-fruits of Ruggles Gates' advocacy of the "convenience and cogency" of human species would be that the latter would prove easier to detect than the conventionally recognized 'races' or variants. However, he does not appear ready yet to adjudicate on the taxonomic rank of the many more or less distinctive groups which he recognizes. (The elaboration and adornment of the charts on p. 56 and p. 161 illustrating these groups need not be taken too seriously.) Towards the end of the book (p. 388) he puts forward five strong claimants to the rank of species in the Caucasian, Mongolian, Australian, Negroid and Bushman stocks; but he does not, unfortunately, justify this selection by any detailed reference to the taxonomic and phylogenetic criteria which he insists are at hand to establish species differences; nor is it made plain in which way these particular 'species' exemplify "consistency in nomenclature and methods of classification". Indeed, it comes rather as an anticlimax to find, near the end of the work (p. 378), that for the conferment of species rank one may have, after all, to fall back on the "opinions of a competent systematist".

Ruggles Gates makes his claim on the score not merely of "convenience"; much of the book is devoted to arguments based on palæontological data. According to him modern man may be grouped in distinct species because the taxonomic differences represent the end-products of evolution along largely isolated lines of development. Continental separation has given rise to the four or five groups which he would regard as distinct species. They have, according to him, been developed from quite separate ancestral stocks of the morphological levels typified by *Pithecanthropus* and *Javanthropus* in the Australian region, *Sinanthropus* in the Far East, Neanderthal man in Europe, and *Africanthropus* and Rhodesian man in Africa. It will be recalled that Weidenreich[1] was the foremost advocate of the view that *Homo sapiens* (the Neanthropic level) had emerged from the more primitive Neanderthal (or Palæanthropic level), and that the latter in turn had its origin in the *Pithecanthropus–Sinanthropus* (or Archæanthropic level). Another view, that of Sergi[2], Le Gros Clark[3], and others, is inclined to the belief that Neanderthal man and *Homo sapiens* represent divergent branches from a geologically earlier group combining features of both, as exemplified in the remains from Steinheim, Saccopastore, Krapina, Mt. Carmel, and elsewhere. There is some uncertainty as to the relationship of this group to the Archæanthropic level.

The emergence of modern man is thus capable of various interpretations, even if it is assumed that the transformation and dispersal at each level have taken place at a single centre. Ruggles Gates finds it easier to believe that this transformation has taken place independently, and presumably at different times, in four or five centres, and that the descendants of these rather dissimilar ancestors have undergone an extraordinary degree of parallelism in their different lineages, yet not enough to obscure their specific differences. It would seem, however, that Ruggles Gates has allowed himself much elasticity in his usage of the concept of 'parallelism'. As applied to man, his usage does not, in spite of his implied claim (p. 39), conform to that of Le Gros Clark. In the latter's interpretation (which is the one generally understood) parallel variations are essentially secondary and often superficial, and this is true, in fact, of many of the accepted cases of parallelism in other animal groups instanced by Ruggles Gates himself. If palæontologists of the standing of Broom and Le Gros Clark do not attribute the humanoid resemblances between *Australopithecus* and *Homo* to merely parallel variations, to describe the similarities among modern men as 'parallelisms' seems completely inconsistent.

Quite apart from the difficulties in Ruggles Gates's phylogenetic interpretations, the arguments based on palæontological data (an impressive compilation in this book) prompt serious misgivings. The author gives credence to many expressions of palæontological opinion which are far from commanding general acceptance. Evidence based on remains such as those of *Eoanthropus*, *Meganthropus*, Kanam man and *Africanthropus*, to mention a few, cannot at the present time, in fact, be used as a basis for any far-reaching generalizations. The material is morphologically and geologically too uncertain. Even where there are well-preserved remains, much caution is needed in accepting the speculations of palæontologists on the affinities of particular fossils. One may take an instance on which Prof. Ruggles Gates places great emphasis—the relationships of the Rhodesian skull. The affinities of this specimen to modern and to Boskop man, to the Bushman, to ancestral Negroes, or Neanderthal man have been interpreted so variously as to yield a remarkable criss-cross of contradictory hypotheses. These probably cancel one another out, as a recent critical article by Dr. L. H. Wells[4] would suggest. In handling the palæontological data, opposing points of view have not, in the reviewer's opinion, been given sufficient critical consideration by Prof. Ruggles Gates. This is the work's most obvious inadequacy, and one which goes far to weaken the thesis the author is so intent to sustain.

J. S. WEINER

[1] Weidenreich, F., "Apes, Giants and Man" (Univ. Chicago Press, 1946).
[2] Sergi, S., *Man*, **48**, 76 (1948).
[3] Le Gros Clark, W. E., *Biol. Rev.*, **15**, 202 (1940).
[4] Wells, L. H., "Robert Broom Commemorative Volume", 133 (Spec. Pub. Roy. Soc. of S. Africa, 1948).

SYLVICULTURAL STATISTICS

The Silviculture Research Code

Vol. 2: The Statistical Manual (Being the Application of Statistical Methods to Silvicultural Research in India). By A. L. Griffith and Bakshi Sant Ram. Pp. viii+214. (Dehra Dun: Forest Research Institute, 1947.) Rs. 11.2; 17*s*. 6*d*.

WORKERS in the biological sciences need statistical methods as a tool in the ascertainment of results to be derived from experimentation; in particular, when experiments are of the field order, modern applications to the design and analysis of experiments, mainly the work of R. A. Fisher, are essential. The question then arises whether certain standard texts are sufficient, or whether there is need for a book dealing with methods particular to the special field. The "Silviculture Research Manual" of 1931 is out of date, and it has been decided to publish a new "Code" in three volumes. The opportunity has been taken to expand the treatment of statistics from a single chapter, by H. G. Champion,

in the former manual to an entire volume which, although vol. 2 of the "Code", is the first to be published.

It is undoubtedly a convenience for sylviculturists to have their own all-embracing text, although as a matter of fact the only feature of the work under review that is peculiar to sylviculture lies in the numerical data and the actual experiments chosen for purposes of illustration. Generally, the volume is an expository presentation of those parts of the theory and application of statistical methods that are needed in the domain of field experimentation. Full acknowledgment is made of the sources of the compilation, and, although the authors are evidently not mathematical statisticians, the selection of the material and the general presentation are on the whole sound, while a welcome feature is the considerable detail given to all the calculations; so much so, indeed, that the impression may have been left that computation is more complex than it really is, and the so-called 'short methods' not very short after all.

Part 1—general principles—covers the standard methods needed for estimation and tests of significance up to analysis of covariance, with an added chapter (the longest in the book) on the fitting of simple curves, which is mathematical rather than statistical, and which could with advantage have been integrated with the general study of regression. Part 2 deals with the design of field experiments, describing the ordinary arrangements up to simple factorial designs, including split plots, and giving consideration to experiments repeated in space and time. With some unnecessary repetition from Part 2, Part 3 rounds off the work with nine full-scale examples. It would have been a convenience to readers to point out that variance-ratio tables are available, with all the other tables required, in a single book, "Statistical Tables", by Fisher and Yates.

The main points of criticism are a need in some places for integration of alternative methods, a faulty comparison of a total and partial correlation coefficient on p. 57, and some confusion regarding the use of interactions in space-time experiments (for example, p. 177). But, in any event, sylviculturists will be safer with this book than with some of those given in the list of references, and the authors are to be commended for a useful compilation which will have a general value outside the forestry service.

J. WISHART

SURVEY OF THE GREAT WORLD RELIGIONS

Ethics of the Great Religions

With some Account of their Origins, Scriptures and Practices. By E. Royston Pike. Pp. viii+247+20 plates. (London: Watts and Co., 1948.) 15*s*. net.

THIS is an attractively illustrated and very readable book, but one which nevertheless cannot be altogether recommended as a reliable introduction to the subject. Any attempt to study the great world religions which treats them as, in essence, no more than a number of ethical systems, converging towards something like agreement, inevitably fails to do justice to the specific *differentia* of each particular religion.

A religion is more fundamentally a metaphysical than a moral system. Its ethical commandments and prohibitions are understood and justified by its votaries in terms of its metaphysic, and not the other way round. Religious morality is always a relative morality of adaptation to presumed circumstances, and never an absolute morality justifying itself in terms of belief in a conscience or capacity for moral intuition which functions independently of all metaphysical beliefs and presuppositions. Thus even when the ethical prescriptions of two different religions appear, when abstracted from their respective metaphysical contexts, to be in fundamental agreement, the appearance is, in fact, a misleading one. For example, one religion may cultivate asceticism because it distrusts personal life and selfhood, and wishes men to lull themselves into self-forgetfulness and resignation by the elimination of desire; whereas another may resort to ascetic disciplines for precisely the opposite reason, because it believes in personal existence and seeks to intensify its powers by discipline and concentration. The resemblance, in such a case, will be accidental and superficial; the differences are essential and profound.

The truth is that comparative religion is a subject most appropriately studied, because most sympathetically and with most insight, by a man of personal religious experience and conviction. To write about the observed phenomena of religion without knowing the inward discipline of 'being religious' is rather like trying to contribute to the progress of physical science without acquainting oneself with the laboratory techniques of controlled observation and experiment which it employs. It may be replied that the teacher who is a disciple of no one of the great world religions is more likely to display impartiality as between them all than, shall we say, a Christian teacher. But this is one of the great errors of so much liberal educational thought. The real virtue of the teacher is not impartiality—a quality which the mere dilettante can simulate easily enough—but justice, the stern intellectual self-discipline which enables a man who has committed himself utterly to the guidance and promptings of his own convictions to look with charity and understanding upon those of others. Thus a book like this fails to satisfy the Christian reader; but it fails equally, and for the same reasons, to satisfy the Moslem or the Buddhist. A Christian writer on the same subject would do justice to the specific *differentia* of Christianity; but at the same time, and as part of the same process, he would also render a similar service to Islam and Buddhism, and leave the Moslem and the Buddhist at all events less dissatisfied.

To the Christian the author's treatment of Christianity seems particularly defective—he shows, for example, no knowledge or even suspicion of the tendency and implications of recent discoveries in the realm of biblical criticism (he is "almost certain" that St. John's Gospel was not written "earlier than 100 A.D.")—but no doubt a Buddhist would feel that his account of Buddhism is his greatest failure, while a Moslem would complain in particular of a pathetic inability to penetrate the secret of the power of Islam. To be equally unjust to everybody is indeed a travesty of real impartiality; but it is often the fate of the secularly minded doctrinaire liberalism which, in the modern world, has brought the genuine liberal values of our culture into their present parlous condition.

J. V. LANGMEAD CASSERLEY

The Penrose Annual

A Review of the Graphic Arts. Edited by R. B. Fishenden. Vol. 43. Pp. xii+140+40+139 plates. (London: Percy Lund, Humphries and Co., Ltd., 1949.) 21*s*. net.

"THE Penrose Annual" is an old friend of all connected with the printing industry, and its return after an absence of nine years is very welcome. This, the forty-third volume, follows the well-established lines of its predecessors, which in some ways is a pity, because in the nine years elapsing between the appearance of Volume 42 and Volume 43 the printing industry has had experiences which should be recorded. And where more appropriately than in "Penrose's"? The record is desirable not only for historical reasons, but also because much valuable experience was gained in solving problems which arise in an industry in total war, and this should not be lost.

The Annual consists of its usual four parts—"General Articles", "Technical Articles", specimens of contemporary printing and advertisements; and each contributes to the usefulness and interest of the book as "A Review of the Graphic Arts", a usefulness which does not diminish as the years pass. The "General Articles" are concerned mainly with typography and design, illuminated by the outstanding contribution of H. J. Deverson, "Photography in Battledress". The "Technical Articles" cover a wide field, and give promise that there may be outstanding technical developments in the printing industry before long. The printing specimens, covering all the major processes, are excellent in quality and show that British printing is second to none. Anyone who has an interest in good printing and in the ways in which it is produced will find much enjoyment in this volume—now and in twenty years time. It is excellent value for a guinea.

If old friendship permits of frankness, it is to be hoped that one or two of the authors, before they make their contributions for Volume 44, will take a little time off from printing to read Sir Ernest Gower's "Plain Words". There is at least one paragraph in Volume 43 which is good enough for *Punch*.

Proceedings of the Aristotelian Society

New Series, Vol. 47: Containing the Papers read before the Society during the Sixty-eighth Session, 1946–1947. Pp. xx+300. (London: Harrison and Sons, Ltd., 1947.) 30*s*. net.

IT is not infrequently asserted that we are unable, these days, to 'afford' pure knowledge, that it is an intellectual luxury, that it should be strictly rationed, and so forth. Luckily, in addition to *ad hoc* protests against a view so shocking, there occur certain periodic implied reactions; the appearance of a new volume of the *Proceedings of the Aristotelian Society* is one of these, and deserves a special welcome.

There is little continuity to be discerned in this collection; indeed, it is scarcely to be expected; the value lies in its 'forge-like' character, wherein thought-stuff is hammered out, fashioned, tempered and annealed. For example, the president's address provides some teleological clothing for E. S. Russell's functional biology; another contributor presents an exceptionally sensitive view of the role of pain in creative activity, while further on we meet with a penetrating analysis of existentialism in terms (largely) of its historical background. Kierkegaard, typical of a 'crisis-philosopher', fastened upon the story of the immolation of Isaac a nineteenth-century reflexion of the extreme credal position assumed ages before by Tertullian. The last paper is a most interesting exposition of the tentative method of approach to logical definition. Thus, in these ways, and in many more, we are refreshed and stimulated; but above all, it is good to know that some people still ponder for pondering's sake, and for no other reason.

F. I. G. RAWLINS

The Making of Scientific Management

By L. Urwick and E. F. L. Brech. Vol. 3: The Hawthorne Investigations. Pp. x+225+8 plates. (London: Management Publications Trust, 1948.) 12*s*. 6*d*. net.

THE findings and interpretation of what are known as the Hawthorne Investigations, carried out in the United States for the Western Electric Co. at its Hawthorne Plant, are of great interest to all concerned with problems of industrial relations and productivity in Great Britain, where the human factor is frequently the decisive one with which management has to deal. These findings, however, have been presented in seven main publications, four of which deal directly with the research activities and their results, while the other three use certain aspects of those findings to illustrate wider industrial and sociological problems of our time, such as that of leadership in a free society. This volume draws freely on those sources, giving a connected critical account which should be welcomed by those to whom the original volumes (some of which are out of print) are inaccessible. It will give most managers a sufficiently detailed account of the investigations, even if perforce some of the stimulus and vitality of Elton Mayo's and T. N. Whitehead's original books are lacking; and the brief notes on the original volumes which are included will direct those who wish to study the findings in more detail to the appropriate source.

R. B.

Report on Fungus, Bacterial and other Diseases of Crops in England and Wales for the Years 1943–1946

By W. C. Moore. (Ministry of Agriculture and Fisheries, Bulletin No. 139.) Pp. vi+90+12 plates. (London: H.M. Stationery Office, 1948.) 2*s*. 6*d*. net.

THE number of plant diseases, or at least the measure of man's awareness of them, is constantly increasing. Mr. W. C. Moore records twenty-six new diseases and twenty-one new host records during the four years 1943–46. It is possible, however, that only one of these new enemies—bacterial canker of tomato—is likely to add a serious challenge to plant pathologists. The disease, caused by the organism *Corynebacterium michiganense*, has appeared on outdoor tomatoes, mostly in the south-east of England, where some of the outbreaks have involved the death of considerable numbers of plants. The bulletin, however, does more than record the appearance of new diseases; it also assesses the status of pathogens which are recognized already. There is a growing tendency for advisory plant pathologists to become more truly quantitative in their estimates of disease, and Mr. Moore draws freely from the reports of his advisory colleagues and other collaborators. Graphs show the comparative phenology of potato blight in Cornwall, Devon and Yorkshire. Maps

show the present position of diseases which are extending geographically, such as red core of strawberries, bacterial canker of tomatoes, asparagus rust, onion smut, and grey bulb rot of tulip. The results of surveys of take-all of wheat, yellows of sugar beet, wart disease of potatoes, and *Didymella* stem-rot of tomato are also given.

It is not the function of this publication to give lengthy descriptions of plant pathogens; but the text nevertheless includes useful notes on some of the more uncommon troubles. Citations of recent and relevant literature are very frequent, and several photographs of particular diseases are reproduced. The whole makes a very modern symposium of plant pathology in England and Wales, showing the success of control measures for some diseases, indicating the need for new methods of prevention or eradication for others; it holds the balance between those troubles which are only of scientific interest and those which provide a serious incubus on crop production.

J. G.

Diseases of Cereals

By Dr. W. A. R. Dillon Weston. Pp. x+69. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 4*s*. net.

HOW cereal diseases can be recognized and controlled is shown in the twenty-six pages of this well-produced and generously illustrated book. The author, as advisory plant pathologist, has devised life-cycles, attractively illustrated by Miss Ann Murray, to demonstrate diagrammatically important stages in the lives of organisms causing cereal diseases and the means by which they can be controlled. These are used with other drawings to illustrate accounts of diseases caused by fungi and other ailments of cereals. The improvement in crop health since seed disinfection became general is indicated.

This book will be particularly useful to farmers and students for whom it is primarily designed; and practising plant pathologists will appreciate the clear and concise accounts showing how modern knowledge is used in controlling disease. M. D. G.

Five-Figure Tables of Natural Trigonometrical Functions

Prepared by H.M. Nautical Almanac Office. Pp. iv + 124. (London: H.M. Stationery Office, 1947.) 15*s*. net.

THESE tables were originally prepared in 1941 by the Nautical Almanac Office, at the request of the War Office, for use in survey calculations. In 1945 they were reprinted, but the present issue, dated 1947, is the first one to become available to the general public. They contain *natural* values only, and are intended to replace similar tables, published in 1924 (in Part 2 of the "Manual of Artillery Survey"), which provided *logarithmic* values of the same four functions. It should be emphasized that they are primarily designed for use with calculating machines and are of no great practical value unless such a machine is available.

There are two distinct sections, in the first of which, the auxiliary section occupying some thirty pages, values of the cotangent are given to five significant figures for every second of arc up to 7° 30′. The main table, comprising ninety pages, contains values of the sine, tangent, cotangent and cosine arranged semi-quadrantally for every ten seconds of arc. In the cotangent tables for the range 27–45°, six significant figures are available, there being five only for the remaining entries. Information supplied at the heading of each third of a page enables the range of the tables to be extended to 360° without difficulty, and as the tabular intervals are so small no differences are provided, as interpolation is not considered necessary.

A short list of minor corrections which have been incorporated since 1945 and another of errata noted after printing are appended; the book is well bound and clearly printed. J. H. PEARCE

Reports of the Progress of Applied Chemistry

Vol. 31, 1946. Pp. 745. (London: Society of Chemical Industry, n.d.) n.p.

IT is unfortunate that, owing to circumstances over which the editors no doubt have no control, the "Annual Reports" for 1946 have appeared only in 1948. Taking into account the fact that the publication of a paper may involve a year's delay, most of the actual work described is from three to four years old.

Apart from this defect, the volume maintains the usual excellence of the series. It is divided into twenty-eight main sections, to which forty-seven well-known authors have contributed. In general, these sections follow the headings adopted by *Chemical Abstracts*. One interesting departure is noted: "Pest Control" is given a separate section of 19 pages with 173 references, thus showing the growing importance of the subject. The main sections are subdivided, making it easy for a reader to look up any subject in which he may be particularly interested. The references cover an extremely wide range, and include papers or patents which may easily be overlooked without such guidance.

The subject-matter, varying from the production of ammonium sulphate in Turkey to the solubility of carbon in molten copper and the disposal of kitchen waste, is too varied to enable even an indication of its nature to be given; but it may confidently be stated that few readers can glance through this volume without catching sight of something of unusual interest. H. E. WATSON

Sequence in Layered Rocks

A Study of Features and Structures useful for Determining Top and Bottom or Order of Succession in Bedded and Tabular Rock Bodies. By Prof. Robert R. Shrock. Pp. xiii+507. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 45*s*.

THE use of features such as graded bedding and cross-lamination, pillow lavas and pipe amygdales, to establish the order of succession in a series of folded strata is but briefly dealt with in text-books of geology. Prof. Robert R. Shrock sets out to describe and illustrate not only these better-known top and bottom criteria, but also all other features, structures and relations which have been or might be employed in determining the original order of succession in sedimentary, igneous and metamorphic rocks. His comprehensive compilation is a work of quite a new kind which can be used with advantage to supplement existing texts of a more general nature. While prepared specifically for students, it will form a valuable review for experienced field geologists, who will undoubtedly find it most stimulating. The illustrations comprise some 500 line drawings and more than 150 photographs, nearly all of which are new to text-book literature. A bibliography of seven hundred items is drawn principally from American and British publications.

COUNT RUMFORD AND THE FOUNDING OF THE ROYAL INSTITUTION

By THOMAS MARTIN
General Secretary, Royal Institution

A HUNDRED and fifty years ago, on March 7, 1799, a meeting was held at the house of Sir Joseph Banks in Soho Square, London, to consider proposals for founding a new scientific institution in London. The gathering in Sir Joseph's principal room or council chamber included a number of peers, members of Parliament and public men, with others distinguished for their scientific attainments or well known for their charitable and philanthropic activities. Those who had been called to the meeting were the contributors of fifty guineas each in response to an appeal "for forming by subscription, in the Metropolis of the British Empire, a Public Institution for diffusing the knowledge and facilitating the general introduction of useful mechanical inventions and improvements, and for teaching by courses of philosophical lectures and experiments the application of science to the common purposes of life".

The founders of the new institution had gone far towards ensuring the success of their enterprise by enlisting the help of Sir Joseph Banks, the all-powerful president of the Royal Society. Such was his influence in all scientific matters at this time that it is doubtful if they could have succeeded had he opposed their plan. As it was, he presided at the meeting, the proposals, which had been printed and circulated, were adopted, and it was resolved to petition His Majesty King George III for a royal charter. A committee of managers was appointed and requested "to take preparatory measures for opening the Institution". Thus by resolution of this original body of proprietors, the Royal Institution of Great Britain, as it was afterwards named in the charter, came into existence.

Sir Joseph presided at the early meetings of the managers, which were held almost weekly at this time, and the Royal Institution owes much to his sponsorship and encouragement; but for the true inspirers and originators of the project we must look in a less obvious, and somewhat unexpected, direction. Among the subscribers who attended the original meeting were William Wilberforce, Thomas Bernard and Count Rumford. Wilberforce, the member of Parliament for Yorkshire, was the great advocate of the abolition of slavery. Thomas (afterwards Sir Thomas) Bernard was the treasurer of the Foundling Hospital. Sir Benjamin Thompson, Count Rumford, was that remarkable soldier, statesman and man of science who had been born in America and had come to England during the War of Independence: he had recently returned to this country after a long period in high office under the Elector Palatine of Bavaria. Only one of these three, Rumford, had scientific attainments to account for his interest in the new institution: but all were actively engaged in humanitarian and philanthropic enterprises, and in particular were associated in the affairs of a society called the Society for Bettering the Condition and Increasing the Comforts of the Poor.

Rumford, whose title as a Count of the Holy Roman Empire had been conferred on him by the Elector Karl Theodor, had spent the most active and fruitful years of his career in Bavaria. It was in Munich that the greater part of his scientific work on heat had been carried out, including his well-known experiment on the source of the heat excited in the boring of cannon at the Arsenal; but his experiments were by way of relaxation, in a life fully occupied with military and administrative duties. In these he had shown great enterprise and versatility, providing the firm hand which was sorely needed by the Elector in the government of his country. Bavaria was suffering from the ravages of war, there was corruption in high places and poverty and lawlessness among the people. Gangs of beggars and vagabonds, many of them ex-soldiers, roamed the country, converging on Munich, where they systematically extorted alms from the more law-abiding citizens.

The state of affairs had become intolerable, and after much consideration Rumford devised a plan, which with the aid of the military he put into operation on New Year's Day, 1790, for arresting all the beggars in the city. The able-bodied were put to useful work in 'houses of industry' and the infirm given alms from funds subscribed by the citizens. Thereafter begging was prohibited. By his humane and enlightened methods with the poor people and his care in the administration of his 'institutions for the poor', Rumford succeeded in making his system work and in ridding Munich of its incubus for a considerable period of years.

He became much interested in the problems of practical philanthropy, and devoted attention to such matters as economy of fuel, the design of stoves and fireplaces, the improvement of cooking utensils and the preparation of nourishing food at a minimum of cost. The fame of his methods spread to other countries, and he was consulted everywhere on the economy of establishments for the poor. 'Rumford soup kitchens' and 'eating houses' were set up in many places. In London he advised on the arrangements at the Foundling Hospital. Its treasurer, Thomas Bernard, was a particular admirer of his methods, and in 1796 proposed the formation of a society to promote their introduction into Britain. The society thus established, with the active co-operation of Wilberforce and other philanthropists, was the 'Bettering' Society mentioned above.

It was naturally with his friends in the Bettering Society that Rumford discussed a particularly cherished scheme, that of an institution to be devoted to the application of science and invention to the improvement of the lot of the poorer classes; and early in 1799 the Society launched the appeal which, as we have seen, resulted in the formation of the Royal Institution. The Bettering Society was thus the precursor of the Institution; but Rumford early decided that this new establishment was too interesting and important to be merely an appendage of another society. In the proposals, therefore, which he drew up himself, and in which its objects were described in great detail, it was given a separate constitution; and as he worked on the scheme its magnitude and its possibilities grew in his eyes. Before long the house in Albemarle Street, which the Institution still occupies, was purchased; and the royal charter was duly granted by the King. At the request of the managers, Rumford went to live at

the house, so that he could personally supervise every detail of the arrangements, and for two years this became his principal occupation.

A special feature of the Institution was to be the Repository or Model-room in which working models of new inventions were to be exhibited. There were to be fireplaces, stoves and kitchen utensils of the latest design. A complete kitchen was to be equipped, from which meals would be served to the proprietors. Workshops would be established and classes held for the instruction of artisans and mechanics. The speedy introduction of all useful mechanical inventions and improvements was to be one of the two principal objects; the other was the application of science to the improvement of arts and manufactures, and for this purpose a lecture room and laboratories would be provided, professors and lecturers engaged, courses of philosophical lectures would be given and chemical and other experiments carried out. For the management of the Institution there were to be committees of managers to govern and direct, and 'visitors' to inspect and audit, responsible to the proprietors, whose interest was hereditary.

For a time the efforts of the early managers met with much success. The ninth Earl of Winchilsea became the first president; the nobility and gentry, the philanthropic and the learned, gave their support as proprietors or subscribers. The lecture theatre, now famous as one of the best for its purpose in existence, was built, the model room, laboratories and workshops constructed and equipped, and the library and reading-rooms opened to the proprietors. Dr. Thomas Garnett, from Anderson's Institution in Glasgow, was engaged as the first professor, and courses of lectures were begun.

This was the Royal Institution as it was originally conceived, and although there have been great changes, those who know it will recognize much that has survived to the present day. It was Rumford's plan, and in the early years his ideas were closely followed. He is rightly regarded as the founder; although by some a share at least of the honours has been claimed for Sir Thomas Bernard.

After a time, however, differences of opinion arose. Rumford quarrelled with Prof. Garnett, and he fell out with some of the other managers, who found him dictatorial and overbearing. Not all of them were in sympathy with his philanthropic ideas or believed that the poor and the working classes in Britain would respond to the methods he had found successful in Bavaria. Moreover, the plan for the Institution proved too ambitious and expensive and had to be curtailed. Rumford began to lose interest; he went off to the Continent again, intending to return; but, in fact, he stayed in Paris to marry the widow of the great French chemist Lavoisier.

The control of the Royal Institution fell into other hands. The new managers quietly dropped the classes for mechanics, the cooking and kitchen economy, and other features of Rumford's plan, and endeavoured to popularize the establishment with those to whom it looked for financial support by arranging courses of lectures on popular science, literature and the arts. Sir Joseph Banks in London grumbled by letter to Rumford regretting his absence, telling him that the Institution was "now entirely in the hands of the profane" and declaring that he would have nothing more to do with it.

But the changes which now took place were due not so much to acts of the management as to the activities and growing reputation of Humphry Davy. Before he left England, Rumford had engaged this young man from Bristol as lecturer in chemistry. Thomas Young had succeeded Garnett, and for a time Young and Davy worked together. Later, Davy became the professor of chemistry, and it is well known how his gifts as a lecturer and his brilliant researches on the chemical action of electricity established both his own reputation and that of the Institution. Scientific research and exposition became the order of the day.

This alteration of purpose was frankly recognized by an Act of Parliament in 1810, which amended the constitution of the Institution, extending its objects to include the "promotion of chemical science by experiments and lectures" and the "diffusion and extension of useful knowledge in general", and substituting for the hereditary proprietors, who were compensated and dispossessed, a body of elected members. Constitutionally, the Royal Institution as we know it to-day dates from the Act of 1810; but its character and traditions were established by the brilliance of Humphry Davy, to be maintained and enlarged by the genius of his assistant and successor, Michael Faraday.

At this hundred and fiftieth anniversary, however, we celebrate the founder, Benjamin Thompson, Count Rumford. He made probably his greatest contribution to its success when he brought Humphry Davy to work in his Institution; and if it is something of a changeling from the establishment he originally intended, none will now deny him credit for the importance of his achievement or its significance in the history of science.

FOREST RESOURCES OF THE WORLD

A SMALL booklet has recently been issued by the Food and Agriculture Organisation of the United Nations, Division of Forestry, entitled "Forest Resources of the World" (Washington, D.C., 1948). This report is of first importance and interest, and discloses the steps which have been taken to have a real inventory of the world's forestry resources prepared, a piece of work far more difficult of achievement than might be supposed. This difficulty is due to the fact that a considerable proportion of the forests of the world are still without any really proper and efficient management. Consequently, any figures obtained on the subject of the abundance or otherwise of their several resources can, in certain cases, be accepted only with reserve.

The report commences with the question as to whether or not man will be compelled to resign himself to a perpetual shortage of forestry products. To this the report's answer is 'No', and this reply applies to a still larger population than at present exists. It will be of interest to follow the argument which, of necessity, must be based to a considerable extent on the still untapped forests of the world.

From earliest times a large section of the world's population has depended on the forest—at first for fuel only, then for timber for house construction, farm implements and so forth. The introduction of more modern forms of building, it was said, would see the importance of timber decrease and, therefore, the people's corresponding dependence on the forest. The reverse has been the case. The modern industrial age has brought with it new demands on wood for direct use in manufacturing industries and for

making the crates and boxes which protect these products in transit. The extraordinary, and certainly not foreseen, development in the uses of wood pulp during the past century has made the forest the primary source of most of the world's paper and of a substantial proportion of its textiles. Wood chemistry is constantly developing entirely new products derived from wood. How great are these increased demands and what bearing have they on the existing forests and possibly newly created forests in the world? For one thing, there is no longer the sharp distinction of utilization which formerly existed between the conifers and the hardwoods. Hardwoods are now converted and used in industry for purposes for which originally only the conifer was considered suitable. This is to the good; and modern machinery and research have made it possible to utilize some of the hardwood species of the mixed tropical forests previously regarded as valueless for commercial and, therefore, sale purposes. Incidentally, this will facilitate the sylvicultural working and management of some of these forests. The other advance which it is imperative should be made is to put an end, in the interests of the world community and not only of those of one particular country, to lumbering in all its forms, with its aftermath so often of bad erosion and destruction, the starting of fires in the debris on the lumbered area, and their spreading into valuable standing forests and often into townships and villages. In this respect the waste in some parts of the world has been enormous; and yet the method still continues in the interests of the few. Less spectacular, but equally serious, is the continuing practice of the removal of forest growing on true forest soils in order to make room for poor and unproductive farms; in the tropics vast areas of forest have been degraded or entirely destroyed by the cycle of shifting cultivation and annual firing followed by excessive grazing, leading to the production of desert condition. With the balance of Nature upset, anything may happen: erosion and loss of valuable top-soil, lowering of water-levels in the soil, floods and devastation caused by such at the lower land-levels.

The first essential steps to ensure the future forest reserves is for the nations to get together and determine the measures required to stop general forest destruction throughout the world. The forester responsible for the well-being and management of the respective forest areas, and the timber and other merchants who extract the varied commodities from the forest and take them to the market, will then all be in a better position to gauge the maintenance of the forest resources position.

A first attempt at a solution was made by Dr. Raphael Zon and Mr. William A. Sparhawk in the United States immediately after the First World War. Their publication of 1922 was followed up by further efforts on the part of Finland and Sweden and by the International Institute of Agriculture at Rome, which published estimates supplied by national Governments in year-books between 1933 and 1948. In 1946, available information on the world's forests was summarized in a report submitted to the second session of the Conference of the Food and Agriculture Organisation under the title "Forestry and Forest Products—World Situation 1937–1946". In the same year, Sir Hugh Watson made a study which appeared in the "British Empire Forestry Handbook".

All these attempts suffered from the inevitable chief drawback—the lack of reliable forest-inventory information, coupled with the lack of common forestry definitions.

How far has this deterrent affected the present publication? At the first session of the Conference of the Food and Agriculture Organisation in the autumn of 1945, the need for knowledge of the forest resources of the world was recognized. Later, it was decided to issue a draft questionnaire to all countries, only questions essential to an appraisal of the forestry situation in each country being included. The preparation of such a document would not appear to offer much difficulty. But the reality was far different. Quite apart from the diversity of forestry definitions, all sorts of other difficulties had appeared, and the final form of the questionnaire was not approved until the meeting of the third session of the Conference at Geneva in August 1947. Even in that final form it was obvious that difficulties, if not ambiguities, remained; for example, for tropical countries, the filling up of such a form for a province in India, with its regulated forest-management extending over a period of eighty years, as compared with one of the South American States where forestry management has scarcely made an appearance.

Herein lies the danger of an attempt to draw up inventories of forestry resources which are based on world figures designed to form a basis for world production and for utilization for a world population, the growth of which in relation to the use of the forest resources available cannot be correlated. A census of the total world population is possible. But attempts at a similar census of the world's forestry resources, given our present actual knowledge of many of the last remaining forestry areas, as, for example, in the Latin American States, or the large area of forest in northern Russia and Siberia, must inevitably detract from the value of world figures. On the other hand, those figures obtainable for the comparatively small area of forest under a high or even modified forestry management will prove sufficiently accurate; but it is dangerous to take estimates based on such figures and apply them elsewhere to forests of which little is known. This has failed before. It is for similar reasons that calculations of the growth and volume of timber to be derived from plantations made on previously bare unafforested lands are likely to be incorrect.

Nevertheless, both the work and the information we have in this booklet are invaluable. At last the difficulties have been clearly seen and thoroughly grasped. Such items as land classification, classification of production forests, land ownership and volume of growing stock, all of them apparently simple divisions of the subject, produced divergencies of interpretation and meaning. Official statements respecting the forest resources of 101 countries and non-self-governing territories were received up to the date of publication. Additional questionnaires were expected, but the widespread interest aroused by the inquiry was considered to justify the publication of the present booklet. The tabular statements are ten in number and are entitled, respectively: response to inventory questionnaire; forested areas of the world; classification of productive forests; land classification; classification of productive forests, contd.; ownership of productive forests; growing stocks in accessible productive forests; average annual growth and annual drain for all species, for conifers only, for broad-leaved forests, respectively.

From the figures obtained, the authors of the report state that the forests of the world are capable of providing "reasonably adequate supplies" to a population larger than now exists. "But," they write, "the provision of such supplies will entail treatment of all productive forests as renewable crops, opening up of forests which are not yet accessible, and cessation of the widespread devastation of forests which, in this twentieth century, still continues."

If this is to come about, Governments, and their responsible ministers, finance members and treasuries, will have to regard the forest and its management as a very different proposition from that envisaged in the past. With the Governments responsible must be included large masses of the populations existing on the globe to-day; for without their intelligent co-operation in forest protection and management, inventories of forest resources may prove misleading and even dangerous. E. P. Stebbing

NON-UNIFORMITY OF THE EARTH'S ROTATION AND GEOMAGNETISM

By Prof. W. M. ELSASSER
University of Pennsylvania

THE existence of a secular deceleration of the earth's angular velocity at a rate

$$d\omega/dt = -2{\cdot}5 \times 10^{-22} \text{ sec.}^{-2} \qquad (1)$$

has long been established from astronomical data[1]. The classical work of G. H. Darwin and of Jeffreys, culminating in Jeffreys's computation of the frictional torque of the oceanic tide, seemed to have settled the theoretical aspects of the problem[2]. Later, de Sitter[3] and Spencer Jones[4] re-investigated the astronomical data. The value (1) is based on data from ancient eclipses and represents the average deceleration over the last two thousand years. Observations of the longitude of the moon, sun and planets over the past two hundred and fifty years show that the mean deceleration during this time was smaller than (1) —according to de Sitter 60 per cent, according to Spencer Jones 35 per cent of (1). Both the ancient and modern data seem trustworthy, and the conclusion is that a change in deceleration during the historical age is most probably real. Quite recently, it has been necessary to reopen the question as new geophysical information has become available. It can now be said that in all probability the deceleration of the earth is produced by two independent agencies: the oceanic tide, and a still very obscure effect in the earth's liquid core. While nothing is as yet known about the dynamics of motions in the core, there is good reason for believing that an appreciable fraction of the retarding torque operates in the core rather than in the oceans. This is perhaps close to the original ideas of Darwin, but the observations that lead to this conclusion are novel.

Let us first give a brief idea of the mechanics of the deceleration. We shall ignore the small solar tide as compared to the lunar tide. The angular momentum of the system earth–moon must be conserved. Darwin and Jeffreys have shown that the orbital motion of the moon takes up the angular momentum lost by the earth; the moon gradually recedes from the earth. Now the ratio of energy to angular momentum for the earth's rotation is $\frac{1}{2}\omega_e$; the same ratio for the moon's orbital motion is $-\frac{1}{2}\omega_m$. But $\omega_e/\omega_m = 28$, and it follows that per unit angular momentum transmitted to the moon, only 1/28 of the rotational energy of the earth is transmitted; the remainder must be used up by friction or other transformations of energy in the earth. The frictional forces produce a couple that retards the earth, and at the same time a force acts on the moon, tending to push the latter away from the earth. One of the more gratifying features of this theory is the fact that the observed deceleration is of the right general order to account for a gradual removal of the moon from an original position very close to the earth to its present distance during the known life-time of the earth.

The new evidence arises from rather unexpected quarters; it is based on geomagnetic observations. As we have endeavoured to show[5], the secular variation of the geomagnetic field can be explained by means of motions of the matter in the earth's fluid metallic core. Such motions induce electric currents in the core, of magnitude $I = \sigma v \times B$, where σ is the conductivity, v the velocity of the fluid, B the existing magnetic field. Bullard[6] has recently come to identical conclusions; he has, moreover, applied these principles to a study of the secular variation, with promising results. In general, an electromagnetic field in the presence of internal motions in a fluid conductor is non-conservative; energy is being exchanged between the field and the motion of the fluid. On the other hand, it can be shown[5] that so long as a parcel of the fluid moves without deformation, or if its deformation is negligible, it carries its electric currents and magnetic field with it unchanged except for the free decay of the currents. One immediate consequence of this is the fact that the observed irregular magnetic field rotates with the earth. Another important consequence will be indicated below.

We have recently come into possession of a most remarkable set of world-wide maps of the secular geomagnetic variation, constructed by Vestine and his collaborators[7]. These are based on an exhaustive evaluation of magnetic data and cover the period 1912–42 in intervals of ten years. The maps show that there are a number of centres of the secular variation scattered about the earth; these centres undergo rapid changes of intensity and also displacements of their position. The similarity of these maps and of ordinary weather charts is amazing, and there is no better way of conveying the idea that the secular variation owes its origin to fluid motions in the core than a contemplation of these maps. There are two independent ways in which the velocity of the fluid can be estimated, first by direct inspection of the displacement of the centres, and secondly from the rate of change of the field, using the electromagnetic theory[5,6]. Both methods give velocities of about 0·1–1 mm./sec. The most interesting feature, however, exhibited by these maps is a general *drift* of the whole pattern of the secular variation in the direction from east to west. It is difficult to assign an exact numerical value to this drift motion, since it is superposed upon the irregular displacement of the centres and is of the same order of magnitude as the latter. In order to have a convenient figure, we may estimate a value of 0·5°/year, which at the equator of the core represents a linear velocity of

1 mm./sec. Since this corresponds to an overall displacement of 15° over the period of thirty years covered by Vestine's maps, it is clear that the westerly drift is a conspicuous effect. There can be no doubt as to its reality. It occurred to us that if such a mean motion exists, it might not have escaped the attention of earlier students of the secular variation. In fact, Bauer[8] stated in 1895 that he found a "westerly wave" of the secular variation, and he traces it back to the middle of the sixteenth century. The mean angular velocity, so far as can be seen from his data, seems about half the value given above. The cause of the discrepancy is not clear; it is, no doubt, connected with the great irregularity of the secular pattern. Further corroboration of the effect may be found in the analysis of magnetic data of the sixteenth and seventeenth centuries by van Bemmelen[9].

On the basis of the theory which explains the secular variation as the result of fluid motions in the core, these observations must needs be interpreted as representing a bodily displacement of the core in the direction from east to west. This result agrees with the above-mentioned theorem, that the magnetic field is carried along unchanged if a bodily displacement of the conductor occurs. In spite of great efforts, we have been unable to devise any other even remotely satisfactory interpretation of the phenomenon. It will be noted that the direction of the drift is such as to indicate a *lag* of the core behind the rotation of the earth. This is the opposite of what one would expect if the earth were decelerated by a frictional torque in the oceans. From quite elementary considerations of mechanics one would expect the core to rotate faster than the mantle. The difference in angular velocity would be determined by the amount of eddy friction at the boundary of the core. Considering the magnitude of the velocities inferred from the secular variation, it seems likely that a turbulent boundary layer does exist at the surface of the core. (This view differs, however, from that of Bondi and Lyttleton[10], who assume laminar flow.)

Our first and natural reaction would be to try to explain away the phenomenon. As already noted, it would be practically impossible to explain it as due to cumulative or systematic errors in the observation. Students of meteorology might be reminded of the belts of alternating easterly and westerly winds which are a well-known feature of the atmosphere, and which adjust themselves so that the mean torque between the atmosphere and the solid earth vanishes. A careful study of Vestine's maps has not revealed any indication of an opposing drift motion; the existing westerly drift seems rather evenly distributed over the whole earth. Again, one might think that the present condition of the core is in the nature of a temporary deviation from its average state. If we assumed that there is no oceanic tide and that the core alone is decelerated at the rate given by (1), it is readily found that it takes 22,000 years to build up a difference in angular velocity of 0·5°/year. Since the mean life-time of the centres of the secular variation is much smaller—a few hundred years at the most—it seems well-nigh impossible to interpret the westerly drift motion as a mere fluctuation.

Hence we must conclude that the earth's core actually rotates more slowly than the solid 'mantle' surrounding it. It follows at once that, owing to eddy friction at the boundary of the core, angular momentum migrates from the mantle into the core. The core must continuously lose angular momentum, and this is impossible unless there is a direct gravitational interaction between the core and the moon such that the angular momentum lost can re-appear in the orbital motion of the moon. Perhaps the interpretation of these results is facilitated by the recent discovery[10] that the core is not homogeneous but contains a central body of as yet unknown constitution. This is indicated by the peculiar behaviour of seismic waves at great depths. The boundary of this central body seems the natural locus of any tidal effects in the core.

It is one of the results of the theory of tidal friction that the dissipation in deep seas is negligibly small. The frictional effects of the oceanic tide computed by Jeffreys[11] arise in shallow basins such as the Bering Sea, the Irish Sea, etc. It is in the nature of such a theory that no great numerical accuracy can be expected from it. We have just indicated that in place of one retarding couple acting on the earth there are two, one in the oceans and one in the core. It is difficult to estimate the relative magnitude of the two, as Jeffreys's theory of tidal friction can scarcely afford a quantitative clue. The moment of inertia of the core is about one tenth of that of the earth. Hence if the 'inner' couple decelerated the core alone, and the 'outer' couple acted on the mantle alone, their ratio would be 1 to 10. Since, however, angular momentum migrates into the core, the inner couple must actually be larger. Just what fraction of the whole retarding torque it constitutes can only be said when it becomes possible to estimate the magnitude of the eddy friction at the boundary of the core. Given the great variability of the secular magnetic field and the inference from it that the motions in the core are highly unstable, an explanation of a change in the earth's deceleration might well be sought along these lines rather than by the assumption of a change of friction in the oceanic tide.

The existence of the westerly drift motion throws an entirely new light on the physics of the earth's interior. It strongly corroborates the theories which connect the phenomena of geomagnetism with fluid motions in the core, in that it reveals the existence of a supply of power for the maintenance of such motions throughout the life of the earth. It has been shown[5,6] that the magnetic field in the interior of the core must be much stronger than the field at the outside, and the energy of this internal field is supplied directly by the fluid motion. Numerical estimates make it appear possible that the conversion into magnetic field-energy replaces mechanical friction in the core as the agent productive of the retarding torque. Whatever the ultimate outcome of these theories, it seems certain that the discovery of the westerly drift motion by Vestine opens up a new branch of geophysical dynamics.

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OBITUARIES

Dr. H. J. van der Bijl, F.R.S.

Dr. Hendrik Johannes van der Bijl, whose death occurred on December 2, was born in 1887. From early childhood he showed that he was of stern stuff and would be different from others. A successful stay at the University of Stellenbosch concluded with a B.Sc. honours degree. He proceeded to Germany, where, at the University of Halle, he obtained the degree of M.A., to be followed later on by the Ph.D. of the University of Leipzig. It was while he was instructor in physics at the Royal School of Technology at Dresden that he came in contact with Prof. R. A. Millikan, who had gone to Germany to deliver a lecture on an aspect of physics with which van der Bijl was also dealing at the time; this meeting laid the foundation for van der Bijl's meteoric career. So impressed was Prof. Millikan that on his return to the United States he advised the Western Electric Company, New York, to employ the serious young South African to pursue research on the triode, which had recently been invented by Lee de Forest, and was just being applied in the fast-developing art of radio.

Van der Bijl's success was remarkable; it came as the result of an indomitable will to accomplish and an uncanny insight into the workings of thermionics, which he had made his special study in Germany. His promotion was deservedly rapid, and he would undoubtedly have left an even greater mark in the United States had he not lent an ear to the cry of his native land in the person of General J. C. Smuts.

So he became technical adviser on industrial development to the Department of Mines and Industries of the Union of South Africa. Apart from a new Weights and Measures Act, he busied himself in the preparation of the proposed Electricity Supply Act of 1922. Like the slumbering industrial giant in the United States which was first awakened by the First World War, so the Union of South Africa was activated from her slow farming and easy gold-mining economy into the first gropings for an industrial economy. Fortunate indeed was it for the Union that it had van der Bijl, with his great natural gifts and unique technical training, his insight into the future, his willingness to dare, his determination to succeed and his genius for planning.

The establishment and success of the South African Iron and Steel Corporation followed in 1928, and by 1947 he had sponsored and developed numerous other projects.

Van der Bijl's early scholastic attainments have already been mentioned; in addition he held the honorary degrees of D.Sc. of the University of Stellenbosch and LL.D. of the University of Cape Town. He was a member of the American Institute of Electrical Engineers, fellow of the Institute of Radio Engineers, fellow of the Royal Society of South Africa, honorary member of the Koninklyk Instituut van Ingenieurs (Holland), foreign associate of the U.S. National Academy of Science, and fellow of the Royal Society. He was also chancellor of the University of Pretoria. He was the author of a large number of scientific and technical works in German and English published in Germany, America and South Africa. His book, "The Thermionic Vacuum Tube, and its Applications", published in 1920, was at the time the best of its kind in the English language.

His industrial career includes a long list of successful chairmanships and directorships. At the time of his death he was chairman of the Electricity Supply Commission, of the South African Iron and Steel Corporation, chairman and managing director of the African Metals Corporation, Ltd., and of many other bodies. As director-general of war supplies and, later, director-general of supplies during the Second World War, he continued and nursed on the road to completion the industrial development of his homeland, which as technical adviser he helped to initiate in 1920. It is worth recording that the British Government consulted him on its proposed bill for the nationalization of the steel industry in Britain.

The confidence South Africa had in his integrity and ability was remarkable, and he inspired all with whom he came in contact with his ebullient optimism and dynamic activity. In the endeavours for the success of his undertakings it was a fight to glorious victory—or destruction. His end came on December 2, at the peak of his career; he was utterly exhausted by a full and exacting life and by a merciless illness.

J. Theo. Hattingh

Rev. J. P. Rowland, S.J.

We regret to record the death of Father James Peter Rowland, until recently director of Stonyhurst Observatory. Father Rowland was a native of Blackburn, born on June 29, 1875; he was educated at Mount St. Mary's College, near Sheffield, and joined the Society of Jesus in September 1894. In October 1919 he was appointed assistant at Stonyhurst Observatory, and became its director in 1932. He was a member of several learned scientific societies, including the Royal Astronomical and Royal Meteorological Societies.

To the general public, especially in East Lancashire, Father Rowland was known chiefly for his weather forecasts, which were published in the local evening papers, and gained a high reputation for accuracy. To the scientific world, however, his work in seismology was of more importance. Considering, indeed, the limitation imposed by a single Milne–Shaw instrument and the difficulties of the situation, Father Rowland's work was remarkable for its accuracy, and won for him a position among the seismologists of Great Britain. He had two notable successes, in the location of the epicentres of the North Sea earthquake of 1931, and the Wensleydale earthquake of 1933, on the latter of which he read a paper before the British Association.

His other work at the Observatory included the routine magnetic observations, the routine solar observations and occasional astronomical work. All these were remarkable for their accuracy, attained in many instances in spite of the difficulties in the accurate use of old-fashioned instruments. It is to be regretted that there is so little published matter connected with his name. In 1933 he published in the *Monthly Notices of the Royal Astronomical Society* the results of his observations of the period of rotation of the planet Saturn, which probably give the value of this as definitively as is at present possible. There are two papers in his name in the *Monthly Notices* on solar and magnetic work, and during his directorship of the Stonyhurst Observatory he was responsible for the Observatory's Annual Report; but apart from these, his publications are no more than brief notes. Nevertheless, in the course of years of routine

observation, especially on sunspots and terrestrial magnetism, he amassed a quantity of material which it is hoped will one day be subjected to profitable analysis.

As a man, Father Rowland had great charm of manner and made many friends, and there was a whimsical mournfulness about him which never failed to amuse those who knew him intimately. He took endless pains to answer the queries of those who wrote to him for information, and in his priestly work was a zealous and sympathetic helper of souls. Towards the end of his life he became rather prematurely aged and enfeebled, and, at the close of 1947, had to retire from all active work. The end came sooner than was expected. He collapsed and was taken to hospital on December 19, and died rather suddenly on the morning of December 26.

We regret to announce the following deaths:

Prof. C. O. Bergstrand, formerly professor of astronomy in the University of Uppsala, on September 27, aged seventy-five.

Prof. Torsten Carleman, professor of mathematics in the University of Stockholm, on January 11, aged fifty-six.

Prof. Walter Garstang, emeritus professor of zoology in the University of Leeds, on February 23, aged eighty-one.

Prof. Douglas Hay, chief mining engineer (management) of the National Coal Board and president of the Institution of Mining Engineers, on February 24, aged sixty.

Prof. Richard C. Tolman, of the California Institute of Technology, vice-chairman of the U.S. National Defense Committee, on August 14, aged sixty-seven.

NEWS and VIEWS

The Crisis in Soviet Science

Last August scientific workers all over the world heard with deep disappointment that the Soviet Union had officially adopted an isolationist attitude on certain branches of biology. For the first time in the U.S.S.R. there was established a 'party line' in one of the natural sciences. Since then there has been speculation as to whether this attitude might extend to other natural sciences, and a recent broadcast from Moscow gives point to these speculations. On January 26, 1949, the philosopher Alexander Alexandrovitch Maximov, who is a corresponding member of the Academy of Sciences, and who belongs to the staff of its Institute of Philosophy, gave a broadcast on the Moscow Radio Home Service. The theme of his talk was the correct Bolshevik attitude to natural science. He attacks those foreign physicists who "regard as synonymous the philosophical definition of matter and the objective idea of reality", and who are responsible for other "idealistic misinterpretations" in relativity and quantum theory. He indicts by name Einstein, Niels Bohr and Heisenberg. He warns his listeners against the "Kantian acrobatics of modern bourgeois atomic physicists". He contrasts the ideology of these "social traitors" in capitalist countries with the scholars in capitalist countries who "raise their voice in support of genuine science, of a scientific materialist outlook"; and he cites with approval Langevin, Joliot-Curie, Blackett, Haldane and Levy. The purpose of the broadcast was twofold: (*a*) to emphasize the importance of a correct philosophical approach to physics, based on Lenin's famous "Materialism and Empiriocriticism", and (*b*) to encourage an attitude of "militant intransigence towards bourgeois idealistic philosophy and sociology".

Botany at Bangor: Prof. D. Thoday, F.R.S.

Prof. D. Thoday retires from the chair of botany at the University College of North Wales, Bangor, on September 30. After graduating at Cambridge, he carried out researches on photosynthesis under the late Dr. F. F. Blackman before going to the University of Manchester as lecturer. Thence he became professor of botany at Cape Town in 1918 and returned to Bangor in 1923. Prof. Thoday has successfully combined arduous teaching duties with active research, in which he has made notable contributions in several fields—the water-relations of plants, plant development and differentiation, and the physiology of succulents. In South Africa he was much interested in the native plants, and several of his investigations concern them; in this connexion he revised the genus *Passerina*. He was president of Section K of the British Association meeting at Dundee in 1939, when he gave a stimulating address on the interpretation of plant structure.

During his tenure at Bangor, Prof. Thoday has seen great developments in his Department, for which he has been chiefly responsible. New laboratories were built in 1926; but these were already congested by 1939 when, owing to the War, accommodation had also to be found for the botany students and staff of University College, London. The latter are grateful for his assistance at a critical time. Plans are now under way for a new building to house the Departments of Botany and Forestry. At Bangor there is intimate contact between these Departments and also that of Agricultural Botany, which Prof. Thoday has greatly fostered, especially as regards instruction in plant physiology and ecology. His staff have made important contributions to the ecology of North Wales and to the algal floras of the area. He has warmly supported Prof. Brambell's plea for a marine biological station on the Menai Straits, now happily being brought to fruition. Both as dean of the College faculty of science and in other ways, Prof. Thoday has taken an active part in College and University administration. On retirement, Prof. Thoday hopes to publish his researches on the developmental physiology and morphology of the mistletoe (*Viscum album*), on which he has been engaged for some years, and to carry out further investigations on other members of the Loranthaceæ in South Africa and elsewhere.

Prof. P. W. Richards

Dr. P. W. Richards, university lecturer and former fellow of Trinity College, Cambridge, has been appointed to succeed Prof. Thoday in the chair of botany at Bangor. His chief interests are in plant ecology and the Bryophyta, and he will have abundant opportunity for their pursuit in one of the richest regions of Great Britain for such studies. Dr. Richards has been a valuable member of the staff of the Cambridge Botany School since 1937, where he has been responsible for the organisation of the practical classes for first- and second-year students and has

taken a principal part in lecturing to them. A noteworthy feature of his teaching has been his wide outlook and his insistence on the study of plants in the field; in this connexion he has conducted many vacation classes in the Lake District and elsewhere. He is one of the editors of the Ecological Society's "Biological Flora of the British Isles", and has encouraged much research on interesting plants.

Dr. Richards has travelled extensively in connexion with his studies of tropical rain forests. In 1929 he was in British Guiana, in 1932 he visited Sarawak, and during 1934–35 and 1947–48 he was the leader of Cambridge botanical expeditions to Nigeria. In addition to publishing papers on various aspects of tropical rain forests he has written a comprehensive book about them, now in course of publication. As a bryologist, Dr. Richards is outstanding, and he is convinced that mosses and liverworts offer a favourable field, hitherto largely unexplored, for experimental studies. He has taken great interest in the Cambridge Botanic Garden. His Cambridge colleagues, while regretting Dr. Richards's departure, congratulate him warmly on his advancement. They prophesy that he will have a very successful tenure of the chair at Bangor. With large developments pending there, Dr. Richards's organising ability and co-operative nature should be valuable assets.

Engineering at Manchester: Prof. A. H. Gibson

Prof. A. H. Gibson is to retire from the Beyer chair of engineering in the University of Manchester in September. He will then have occupied this famous chair for twenty-nine years, with a distinction well worthy of the traditions created by his master, Osborne Reynolds. Both at Manchester and in his inspiring re-organisation of the Engineering Department of the University of St. Andrews between 1909 and 1920, Prof. Gibson has maintained a firm belief in Reynolds's conception of the aims and methods of university education in engineering: to teach fundamentals and "the physical laws on which mechanics as a science are based"—and to eschew 'spoon-feeding'. His original work is described in an impressive series of books and papers remarkable for the clarity of his writing, the directness of his arguments and the skill of his experimenting. A very few titles taken at random reflect the range of his interests: "On the Depression of the Filament of Maximum Velocity in a Stream flowing through an Open Channel"; "On the Local Intensification of Draught produced in a Horizontal Air Current by the Presence of an Inclined Rod"; "A Study of the Circular-Arc Bow Girder"; "The Behaviour of Bodies Floating in a Free or a Forced Vortex"; "Piston Temperatures and Heat Flow in High Speed Petrol Engines"; "Tidal Model of the Severn Estuary".

Prof. Gibson was for a time simultaneously a member of the Severn Barrage Committee and of the Air Ministry Engine Research Committee. Since 1926, however, his special interest has been in the use of hydraulic scale-models, and a natural outcome of his great efforts in this field was the establishment in 1946 of the Hydraulics Research Organisation of the Department of Scientific and Industrial Research. At the present time, no fewer than six university chairs are occupied by former students and members of his staff, and his personal influence among students and practising engineers alike is as significant as (to quote the citation of the Ewing Medal awarded to him in 1938) his "specially meritorious contributions to the science of engineering in the field of research".

Prof. W. R. Hawthorne

William Rede Hawthorne, who is succeeding Prof. A. H. Gibson, was educated at Trinity College, Cambridge. He obtained first-class honours in the Mechanical Sciences Tripos and was awarded the Rex Moir Prize. On leaving Cambridge he joined the firm of Babcock and Wilcox, where for a short time he worked on boiler research. He then obtained a Commonwealth Fund Fellowship, which enabled him to go to the United States and work for two years at the Massachusetts Institute of Technology on combustion research. On the completion of this work he returned to England to his old firm. When the Second World War broke out he joined the research staff of the Air Ministry, being later transferred to the Ministry of Aircraft Production. He worked for a short time at the Aircraft Testing Establishment at Boscombe Down and then moved to the Engine Department of the Royal Aircraft Establishment at Farnborough. At Farnborough he was quickly drawn into the work proceeding there on gas turbines, and in a short time was put in charge of this work. In 1944 Dr. Hawthorne was transferred to the headquarters branch of the work, where he became responsible for directing the work on gas turbine research. At the end of the War he returned to the United States and took up a post as lecturer at the Massachusetts Institute of Technology, where he is at present the Westinghouse professor of gas turbines. Prof. Hawthorne is known for the researches directed by him on gas turbines during the War and for his interest in the combination of fluid flow and combustion usually termed 'gas dynamics'.

Scientific Civil Service: Promotion of Individual Research Workers

It is announced that additional special posts have been created this year for individual research workers of exceptional quality under provisions included in the White Paper on the Scientific Civil Service (Cmd. 6679, 1945). In recognition of their personal work, promotion to these posts in the grade of senior principal scientific officer (salary scale, £1,320–£1,520) has been awarded to the following officers: C. A. Adams (Ministry of Supply), a mathematical physicist whose researches in ballistics and in ultra high-speed photography have led to results of the highest importance; Dr. H. A. Baylis (British Museum (Natural History)), a systematic zoologist, who has made notable contributions to our knowledge of the parasitic worms, particularly those of importance in medical and veterinary work; Miss F. B. Bradfield (Ministry of Supply), whose numerous contributions in aerodynamics to aeronautical research have been of outstanding scientific and industrial value; H. C. Calpine (Admiralty), a pioneer in radar, who has contributed in a large measure to the successful development of naval fire-control radar, and is now engaged on research into the difficult problems of weapon control; W. G. Campbell (Department of Scientific and Industrial Research), who has made many original contributions to the chemistry of wood, some of considerable technical importance; J. N. Carruthers (Admiralty), whose investigations on tidal currents have earned for him an international reputation, and who has brought together a valuable oceanographical library; J. S. Dick (Ministry of Supply), a physical chemist and a leading authority on pyrotechnics who has a long record of outstanding achievements in this field; J. W. Fisher (Admiralty),

who is engaged on theoretical and experimental investigations in hydrodynamics and acoustics with special application to the reduction of ship noise and to the examination of cavitation phenomena; H. L. Green (Ministry of Supply), who has made important contributions to the study of particle suspensions and has developed this branch of physics to a very high degree of precision; J. S. Hey (Army Operational Research Group, War Office), who, in the course of his work on radar and the ionosphere, has carried out important investigations on abnormal radiations from the sun and the galaxy and on echoes due to meteors; Dr. H. London (Ministry of Supply), a physicist whose outstanding work before the War was on the effect of high frequencies on supra-conductivity; more recently, he has worked on the separation of stable isotopes, and has achieved results of considerable practical and theoretical importance in the separation of carbon-thirteen by low-temperature distillation; A. R. Rangabe (Admiralty), who was concerned prior to the War with the development in industry of electronic tubes of all descriptions; his ingenuity and flair for developing manufacturing techniques, and his understanding of the problems and difficulties in manufacture, have particular significance at the present time; Dr. E. Roberts (Ministry of Supply) has a long and successful record of important and fundamental work on diverse aspects of the chemistry and production of explosives.

National Institute of Sciences of India: New Fellows

At the meeting of the National Institute of Sciences of India on January 4, 1949, the following elections were announced. *Honorary Fellows:* Prof. Louis de Broglie, professor of theoretical physics, Poincaré Institute, Sorbonne, Paris; Prof. Hans von Euler, emeritus professor of chemistry, University of Stockholm; Dr. Harlow Shapley, director of Harvard Observatory, Cambridge, Mass.; Prof. Georg Tischler, Botanical Institute, University of Kiel. *Ordinary Fellows:* Dr. J. L. Bhaduri, lecturer in zoology, University of Calcutta; Dr. S. Bhagavantam, scientific liaison officer for India in the United Kingdom; Dr. S. K. Chakrabarty, director, Colaba and Alibag Observatories, Bombay; Dr. D. Chakravarti, lecturer in chemistry, University of Calcutta; Dr. M. Damodaran, assistant director, National Chemical Laboratories, Delhi; Dr. B. K. Das, professor of zoology, Osmania University, Hyderabad-Deccan; Dr. Kurien Jacob, palæobotanist, Geological Survey of India, Calcutta; Dr. T. S. Mahabale, lecturer in botany, Royal Institute of Science, Bombay; Dr. H. K. Mitra, refractories engineer, Tata Iron and Steel Co., Ltd., Jamshedpur; Dr. K. Mitra, officer in charge, Nutrition Scheme, Public Health Laboratories, Patna; Dr. A. H. Pandya, director, Hindusthan Aircraft, Bangalore; Dr. N. Parthasarathy, geneticist, Indian Agricultural Research Institute, New Delhi; Dr. C. Racine, professor of mathematics, Loyola College, Madras; Dr. K. C. Sen, director, Indian Dairy Research Institute, Bangalore; Dr. R. S. Varma, reader in mathematics, University of Lucknow.

Production of Radioactive Isotopes in Britain

The large atomic pile (BEPO) at the Atomic Energy Research Establishment, Harwell, has begun operating for the production of radioactive isotopes. When it is working at full power later this year, it will be able to produce all the artificial radioactive isotopes required in Great Britain by medical, industrial and other research workers. More isotopes will also be available for export, and it is expected that a steadily increasing demand for them will develop overseas. Materials irradiated in the new pile will be twenty times more active than those so far irradiated in the first and smaller pile. The new pile has a rated output of 6,000 kW. and was designed primarily for experimental purposes. The smaller pile, designed to develop about 100 kW. of heat, started up in August 1947 and has been producing radioactive isotopes since September of that year. Present production is about a hundred and fifty specimens a month.

Vegetation-types Map of Tanganyika

The *Geographical Review* has published a reprint of an article from the January 1949 issue entitled "A Vegetation-types Map of Tanganyika", by the late Clement Gillman. This study of the natural vegetation of Tanganyika Territory by a man who had profound knowledge of the country and of its people is one that should be used as a basis for wise planning, and development. The classification is strictly physiognomic and provides an essential basis for further ecological and geographical investigations. The vegetation of the greater part of Tanganyika Territory is a mixture of woodland or bushland with grassland, the distribution being primarily determined by variations of soil and water conditions and the use made of them by man, although, as the author points out, topography and tectonics influence the climate and distribution of vegetation. The main types shown on the coloured map on a scale of 1 : 2,000,000 include forest, woodland, bushland and thicket, grassland, permanent swamp vegetation, desert and semi-desert, and vegetation actively induced by man in native and non-native cultivations. The term "actively induced vegetation" includes the mixed and constantly changing pattern of cultivated crops, pastures and interspersed remnants of the original vegetation and of scattered small areas of secondary growth. Complexes of vegetation occurring in close conjunction are shown on the map symbolically, using the colour of the dominating type for the ground colour with intrazonals or complexes shown by circles or dots in the colour of their type. Sequences of vegetation types caused by regularly repeated physiographic or hydrographic conditions are shown as "catenas"—a word originally applied to soils in East Africa. The map brings out at a glance the small remnants of evergreen forest left on the main watersheds, and the author stresses the urgency of the threat to the country's water resources. The map also rectifies a commonly held exaggerated view of the size of alien plantations and farming settlements, which appear as tiny specks compared with the great extent of native-cultivated land.

Statistical Estimation

The current mathematical theories concerned with the estimation of one or more unknown parameters in a frequency distribution have been the occasion of much controversy, and the absence of a systematic review of this field at a sufficiently elementary level has been a serious obstacle to the student. Two recent articles by Dr. Leon Solomon published in the *Journal of the Institute of Actuaries Students' Society* (**7**, 144 and 213) go a long way towards meeting this need, and form a most welcome addition to the literature. The first article is chiefly concerned with 'point' estimation. The concept of sufficiency is discussed, the minimum-variance theorem is proved, and

the method of maximum likelihood is introduced, the proofs of its main properties being given in outline. The second article is concerned with 'interval' estimation, first from the point of view of the theory of confidence intervals and then in terms of fiducial probability, the contrast between these two methods of approach being illustrated by a discussion of the Behrens–Fisher problem. Rigorous proofs of the theorems are not attempted, and the emphasis throughout is laid on the new ideas which are involved. Another welcome feature of the presentation is the inclusion of many worked examples.

Chemical Society's Anniversary Meeting: Chemistry and Atomic Research

THE Chemical Society is holding its anniversary meetings for 1949 in Oxford, during March 28–30, and then in London, during March 31–April 1. The keynote throughout these meetings will be the recent chemical developments in the field of atomic energy and the way in which radioactive elements may be used in chemical and biochemical investigations. A noteworthy feature is that the Ministry of Supply has invited a number of distinguished men of science from Europe and America to participate in the general discussion and interchange of ideas; it is expected that the following will be present: Prof. R. E. Connick, Prof. J. W. Irvine, Dr. G. Wilkinson (United States); Dr. G. Bouissères, Dr. J. Gueron, Dr. B. Goldschmidt, Dr. M. Haissinsky (France); Dr. L. Yasse, Dr. R. H. Betts (Canada); Prof. O. Hahn, Dr. F. Strassman (Germany); Prof. G. Hevesy (Denmark); K. E. Zuimen, H. Hillert, G. Johannson, E. Berne, R. Lidner (Sweden). The Oxford meeting, at Rhodes House, South Parks Road, will be devoted principally to a symposium on "The Chemistry of the Heavy Elements", consisting of four sessions under the chairmanship of Dr. R. Spence (for the first two), Dr. E. Glueckauf and Dr. J. S. Anderson respectively. This symposium has been arranged in conjunction with the Chemistry Division of the Atomic Energy Research Establishment, and the programme will include a visit to Harwell. In addition, there will be two sessions on "Radioactive Tracers", the first session, "Preparation", being under the chairmanship of Dr. J. M. Fletcher, and the second, "Nuclear Aspects", under Dr. W. Wild. March 31 will be devoted to the annual general meeting of the Chemical Society, and this will be held at Burlington House, London, W.1. The Longstaff Medal will be presented to Sir Cyril Hinshelwood, and this will be followed by Sir Ian Heilbron's presidential address: "Concerning Amino-Acids, Peptides and Purines". On April 1, at the Institution of Civil Engineers, Great George Street, London, S.W.1, there will be a discussion on "The Use of Radioactive Tracers in Chemistry". This will be divided into two parts: the first, on "Applications in Inorganic and Physical Chemistry", with Prof. F. A. Paneth in the chair, and the second, on "Applications in Organic Chemistry and Biochemistry", with Prof. G. Hevesy presiding.

Acoustics Measurements on Church Bells

DURING the Second World War, when the Germans occupied Holland, they ordered that church bells should be collected to provide a source of bronze for war prospects. This plan met with great resistance from the Dutch, so that after the liberation, several hundreds of bells of different origin and ages, which had escaped being melted down, were gathered at a number of places. At the end of the War, the Dutch Department for Research in Arts and Measurements took the opportunity to collect complete information on the æsthetic and acoustical properties of these bells, many of which were two or three hundred years old. Part of this work was carried out by E. W. van Heuven, who is to read a paper on this investigation at a meeting of the Acoustics Group of the Physical Society, to be held at the Royal Society of Arts, John Adam Street, London, W.1, on March 18 at 3 p.m.

Announcements

THE Committee for Agricultural Research of the Privy Council has appointed Prof. James Gray, professor of zoology in the University of Cambridge, to be a member of the Agricultural Research Council. This is Prof. Gray's second term of office as a member, his first being during 1942–47.

IT is announced from the University of London that Dr. J. H. Taylor has been appointed to the University chair of geology tenable at King's College as from October 1, 1949. The following doctorates have been conferred: *D.Sc.* on Mr. R. L. Wain (reader at Wye College); *D.Sc.*(*Eng.*) on Mr. A. R. Collins (Imperial College of Science and Technology).

MR. A. L. FLEET, formerly assistant secretary and registrar of the University of Bristol, has been appointed assistant secretary of the Association of Universities of the British Commonwealth, the office of which is now at 5 Gordon Square, London, W.C.1.

THE Rouse-Ball Lecture in the University of Cambridge will be given by Prof. W. Pauli, of Zurich, at noon on March 10. His subject will be "Physical and Mathematical Aspects of Recent Developments in Quantum Electrodynamics". The lecture will be in English and open to all who are interested.

A MEETING at Göttingen of the Deutsche Bunsengesellschaft für physikalische Chemie has been arranged for April 23–24, 1949.

THE Institute of Welding and the British Welding Research Association are arranging a Conference on "Welding as an Aid to the Saving of Steel and Manpower", to be held at Ashorne Hill, near Leamington Spa, during March 22–25. Applications for tickets and all correspondence should be addressed to the Secretary, Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1.

UNDER the terms of a grant from the Cotton Industry War Memorial Trust, the Textile Institute is offering to young craftsmen in the cotton spinning and weaving industry a three-year scholarship (of about £750 total value) to study textiles at a university. This scholarship is in addition to the new £1,000 open scholarship of the Institute. Details of both scholarships are available from the General Secretary, Textile Institute, 16 St. Mary's Parsonage, Manchester 3.

THE Institution of Naval Architects is offering the following scholarships to British subjects less than nineteen years of age: Trewent, for naval architecture, £175 a year, tenable at the Universities of Durham, Glasgow, Liverpool, and the Royal Naval College, Greenwich, for 3–4 years. Denny, for marine engineering, £130 a year, tenable for four years at the University of Glasgow. Entries for the above close on May 31. Full particulars may be obtained from the Secretary of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Measurement of Sperm Activity before Artificial Insemination

THE successful application of artificial insemination largely depends on the possibility of making a quick assessment of sperm activity in the sample of semen to be employed. The existing methods of assessing sperm activity suffer from certain disadvantages. They are either subjective, depending on the judgment of an individual who has often examined semen under the microscope, or they involve chemical treatment which may take some time to complete. The most satisfactory is the fructolytic test, which not only gives a combined measure of sperm motility and density[1], but also provides an indication of the hormonal (testosterone) activity of the bull[2]. On the other hand, samples have to be taken from the ejaculate and incubated at 37° C. for one to three hours.

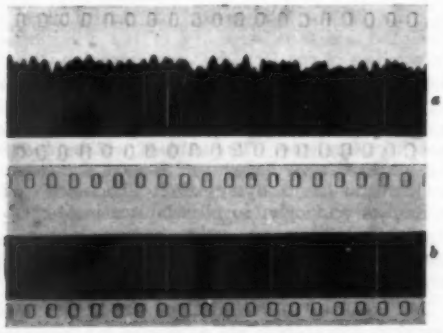

Fig. 1(*a*). Impedance of ram semen containing active spermatozoa. (*b*) Impedance of the same semen after spermatozoa have become motionless. Time-marker, 30 sec.

These difficulties are avoided to a considerable extent by an electrical method of assessing sperm activity. The method is based on the observation[3] that ram semen, when active, exhibits well-defined periodic changes in electrical impedance (Fig. 1). As a result of the experiments on ram semen it was predicted that analogous electrical changes in the semen of other mammals might be too small to observe, or non-existent, unless the density of the sperm were augmented by centrifugation. It has, however, been possible to observe and measure the electrical changes in bull semen with a portable apparatus. Experiments to determine the relative merits of this and other methods of assessing sperm activity have been started; but as these may involve correlating conception-rates with assessments of sperm activity determined in different ways, the results may be considerably delayed.

The apparatus for measuring the electrical changes is mains-operated and consists of a conventional alternating current bridge, energized by a 5-kc. oscillator. The detector is an oscilloscope with amplifier. The method of presenting the data on the oscilloscope is largely a matter of personal choice. For visual observation the electrical changes are usually made to tilt or widen an elliptical trace on the screen. A pair

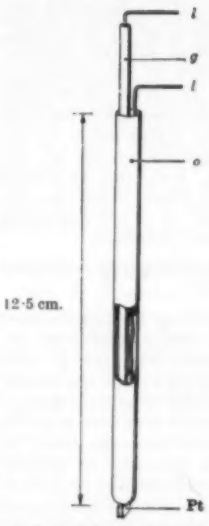

Fig. 2. Electrodes for use with bridge. Pt, platinized platinum plates; *l*, leads to bridge; *g*, insulating glass tubing; *o*, outer glass tubing

of platinized platinum electrodes (Fig. 2) dip into the semen, in a test-tube or centrifuge tube, preferably in a 'Thermos' flask containing water at 37° C. This forms the unknown arm of the bridge, the voltage across it being about 50 millivolts. Trials are in progress to determine whether this treatment has any influence on the fertilizing capacity of the spermatozoa. At the beginning of an experiment, the resistance and capacity of the unknown arm are approximately balanced. If the semen is fresh and the sperm both active and sufficiently dense, periodic impedance changes, which have the following characteristics, are observed: (1) The frequency is maximal immediately the semen has been collected (Fig. 1*a*). (2) When the sperm are dead or only feebly motile, the frequency is zero (Fig. 1*b*). (3) The frequency is reduced by lowering the temperature, and vice versa. (4) The initial frequency can be maintained by adding phosphate buffer to the semen; this treatment also maintains the fructolytic activity at a high level[1]. (5) The changes can be markedly amplified by increasing the sperm density of the sample.

These impedance changes are unlikely to be caused by alterations in the electrical characteristics of individual spermatozoa, such as take place in a contracting muscle fibre; they are probably due to periodic variations in the positions of sperm in the measuring system. The changes are believed to be connected with the 'turbulent wave formation' that is characteristic of active and dense suspensions of bull or ram spermatozoa (Fig. 3). This wave formation represents a periodic aggregation of spermatozoa, the tails of which probably beat synchronously in the aggregations.

The electrical method of measuring sperm activity has the following advantages: (1) Measurements can be made on the semen while still in the glass receptacle at the end of the artificial vagina, or, if necessary, on a separate ½ c.c. sample. (2) Measurements take about five minutes, after which an 'impedance

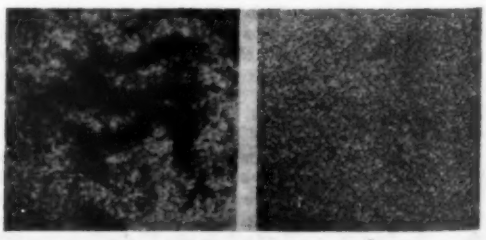

Fig. 3. (*a*) Active suspension of bull spermatozoa showing wave formation. Magnification, approx. 40. (*b*) The same suspension of bull spermatozoa after activity has ceased. Magnification, approx. 40

number' (number of spikes/min.) can be assigned to the sample. (3) The method is quantitative and non-subjective. Photographs can be taken for record purposes. (4) The apparatus is portable and the method of operation can be learnt in a few hours.

The main shortcomings of the method are, first, that it will not provide an assessment of activity unless the semen is sufficiently dense. This may not be serious, as whenever wave formation occurs in semen, impedance changes are observed. Wave formation is usually accepted as a necessary characteristic of semen for use in artificial insemination[4]. Secondly, although the evidence suggests that the frequency of the impedance changes is proportional to sperm activity, further experiments, and, in particular, parallel measurements of fructolysis, impedance numbers and conception-rates, are necessary before the practical value of this method of assessing sperm vitality can be finally established.

A word of warning is perhaps necessary about the assessment of the fertilizing capacity of sperm samples from measurements of sperm activity. Many other factors, apart from the ability to move fast, go to make up the fertilizing capacity of a spermatozoon. If this were not so, intergeneric crosses would be possible. Equally, metabolism and motility are not necessarily related to each other in a simple way. Mann and Lutwak-Mann[5] have shown that, in ram semen, both motility and fructolysis can be inhibited by sodium fluoride without respiration being affected to the same extent, while I have found[6] that the oxygen uptake of sea-urchin spermatozoa can be greatly reduced by carbon monoxide without any corresponding decrease in motility.

This work has been carried out in close co-operation with Dr. T. Mann of the Molteno Institute, Cambridge, Dr. L. E. A. Rowson of the Artificial Insemination Centre, Cambridge, and Dr. A. Walton of the Animal Research Station, Cambridge. Part of the cost of this work was defrayed by a grant (March 11, 1948) from the Agricultural Research Council to the Department of Zoology, Cambridge, for a laboratory assistant.

ROTHSCHILD

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Photosynthesis in Leaves at Very Low Carbon Dioxide Concentrations

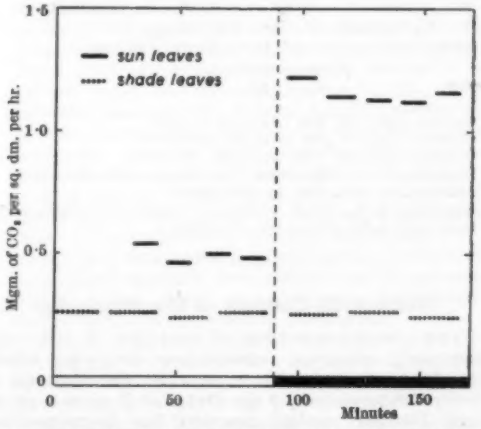
THE photosynthesis of foliage leaves in air free from carbon dioxide is restricted to a re-assimilation of the carbon dioxide which originates from the respiratory process.

Garreau, in the middle of the nineteenth century, demonstrated that green leaves expired carbon dioxide in glass chambers containing small shallow dishes with lime water, or barium hydroxide, when they were exposed to diffuse daylight[1], or even direct sunshine[2,3], that is, the re-assimilation was not complete in surroundings with low carbon dioxide concentrations. F. F. Blackman[4], who, in 1895, placed leaves under similar conditions in a gas stream, could not verify these observations. He concluded that "in bright light a fully green leaf assimilates all the carbon dioxide that it is forming by respiration and none escapes from it". This was the general conception up to 1947.

In this year Audus and Gabrielsen[5], independently of each other, published results which definitely contradicted those of Blackman. Audus performed his experiments in streaming air and exposed the leaves to electric light (intensities up to 3,000 candle-power, or approximately 35,000 lux). He found that the leaves could not re-assimilate more than about nine-tenths of the respiratory carbon dioxide, even at the highest light intensities. Gabrielsen enclosed his leaves in a six-litre flask, illuminated with 10,000 lux, and observed carbon dioxide evolution until a level of about 0·009 vol per cent was reached; these and other static experiments suggest that the photosynthetic process necessitates a concentration of 0·009 vol. per cent carbon dioxide in the surroundings of the assimilation centres before they start working. The rate of carbon dioxide evolution was found to be almost identical for leaves held in light, or in the dark, so long as the carbon dioxide concentration around the illuminated leaves did not exceed 0·006 vol. per cent.

The re-assimilation problem has now been the subject of further studies. Leaves with a total area of 140–170 cm.^{2} were placed in a chamber (150 × 150 × 10 mm.) through which a steady current of carbon dioxide-free air was maintained. The liberated carbon dioxide was absorbed in 0·025 *N* barium hydroxide in a Boysen Jensen tube and measured for periods of 10–20 minutes duration. The temperature of the mesophyll was controlled by means of thermo-couples and kept at the same level (± 0·2°) in dark and in illumination experiments.

The results of two typical experimental series (at 20° C. and a flow-rate of 14·8 ml. air/cm.^{2} min. in the leaf chamber) are given in the accompanying graph. Solid lines illustrate results of experiments with sun leaves of *Sambucus nigra* (leaf thickness about 0·23 mm., fresh weight per dm.^{2} 2·51 gm.); dotted lines indicate results of experiments with shade leaves of the same species (leaf thickness 0·13 mm., fresh weight per dm.^{2} 1·34 gm.). The different behaviour of the two kinds of leaves is obvious. In the



Output of carbon dioxide from leaves in light and in the dark. White part of the axis of abscissæ, illumination intensity of 10,000 lux; black part, dark experiments

relatively thick sun leaves with a high rate of respiration, 56 per cent of the respiratory carbon dioxide is re-assimilated; in the thin shade leaves, in which the respiration-rate is less than one-fourth of that found for sun leaves, no photosynthesis occurs at all.

Further experiments with *Sambucus nigra* leaves and leaves of other species revealed the following facts: (1) The ratio of the re-assimilation-rate to that of respiration (Q_r) is highest in leaves with high respiration-rates. (2) A comparison of Q_r in thick and thin leaves with identical respiratory-rates shows that the highest values are found in the thick ones. (3) Experiments at different temperatures with one and the same batch of sun leaves show a diminishing of the Q_r values with decreasing rate of respiration. When this latter rate is lowered from 0·58 at 20° ($Q_r = 0·41$) to 0·12 mgm. CO_2/dm.² hr. at 5°, no photosynthesis is observed. (4) Re-assimilation begins in shade leaves when the respiration is elevated from 0·31 at 20° to 0·58 mgm. CO_2/dm.² hr. at 30° ($Q_r = 0·24$). (5) A variation of the flow-rate of the air in the leaf chamber does not affect the respiratory-rate but shows a marked influence upon the rate of photosynthesis. When the flow-rate is increased from 15·0 to 32·9 ml. air/cm.² min. for sun leaves having a respiratory intensity of 0·62 mgm. CO_2/dm.² hr., the value of Q_r is reduced from 0·50 to 0.

These findings demonstrate that the photosynthesis under the given conditions depends upon: (1) the rate at which carbon dioxide is produced in the leaf; and (2) the rate at which the carbon dioxide is transported from the leaf to its surroundings. If the respiration-rate is low, and/or the possibilities for carbon dioxide to escape are great, no photosynthesis takes place. It is obvious that photosynthesis only occurs when a certain amount of carbon dioxide is accumulated in the green cells. Thus the experiments bring further evidence for the theory of the existence of a threshold value for carbon dioxide concentration in photosynthesis of leaves. The results of the experiments with shade leaves, and the other experiments in which identical rates of carbon dioxide evolution are observed during dark and illumination periods, make it evident that the intermediate products of respiration are not re-utilized in photosynthesis.

A detailed report will appear in *Physiologia Plantarum*.

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Sept. 15.

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Nucleotide Content of the Nucleolus

The plasmosome type of nucleolus is the only commonly observed intranuclear structure which clearly is not chromatin, from which the nucleolus is easily distinguished by the fact that it gives a negative Feulgen nucleal reaction for desoxypentose nucleic acid. Although it is thus evident that the nucleolus probably does not contain the characteristic polynucleotide of chromosomes, the shape of the ultra-violet absorption curve shows that there is considerable nucleotide of some type in the nucleolus[1]. The basophilia of the nucleolus is attributed to this nucleotide. It can be inferred that at least a part of the nucleolar nucleotide is ribonucleic acid from the fact that ribonuclease reduces the capacity of the nucleolus to bind basic dyes[2]; but this conclusion is open to the objection that the nuclease used was probably contaminated with some protease activity[3].

This communication reports the results of a quantitative study of the effects of chemical extraction[4] and digestion by protease-free ribonuclease[5] on the ultra-violet absorption of the large, homogeneous nucleoli which occur in early meiotic prophase nuclei of sporocytes of *Zea mays*[6]. Each absorption determination was made through a central cylindrical area of a whole nucleolus, in paraffin sections of material fixed in Carnoy's acetic alcohol, using a quartz microscope and suitable photometric apparatus[7]. In each of the three experiments the extraction or digestion caused approximately the same percentage reduction of the extinction (about 53 per cent), which shows that each time the same total mass of absorbing substance was removed from the nucleoli.

Effects of chemical and enzymatic removal of nucleotide from fixed nucleoli of sporocytes of *Zea mays*, measured by ultra-violet absorption

Treatment	Number of nucleoli	Mean E_{2537}	Reduction of extinction	Percentage reduction
		Experiment No. 1		
None	23	0·874 ± 0·010		
Hot TrAc	10	0·407 ± 0·009	0·467	53·4
		Experiment No. 2		
None	17	0·843 ± 0·016		
Ribonuclease	17	0·395 ± 0·010	0·448	52·8
		Experiment No. 3		
None	31	1·000 ± 0·014 *		
Cold TrAc	31	0·860 ± 0·011	0·140	14·0
Hot TrAc	30	0·472 ± 0·008	0·528	52·8

Abbreviations: E_{2537}, extinction at wave-length 2537 A.; TrAc, 5 per cent trichloracetic acid. * The higher extinction values of Experiment 3 are due to the fact that absorption was measured through a narrower central area of the nucleolus, with a correspondingly longer optical path

All nucleotides are soluble in hot 5 per cent trichloracetic acid[3], and therefore the amount of reduction of extinction caused by this treatment, Experiment 1 (0·467), is a measure of the *total nucleotide content of the nucleolus*. The residual light loss, or blank (0·407), is presumably due to specific protein absorption and to non-specific light reflexion and scattering[4,5]. All this nucleotide absorption is removable by ribonuclease digestion, Experiment 2, which shows that the *nucleolus contains only nucleotide of the ribose, or pentose, type*. Slightly more than one-fourth of the nucleotide is soluble in cold 5 per cent trichloracetic acid, indicating that this proportion is a *lower nucleotide polymer than nucleic acid*[3]. There is evidence that fixation in Carnoy's fluid removes from cells practically all the common acid-soluble mononucleotides[6], which suggests that the cold acid-soluble nucleolar nucleotide which survives Carnoy fixation may be a polymer which is intermediate between mononucleotide and nucleic acid. One of the interesting possibilities raised by the presence of this smaller ribose polynucleotide is that

the nucleolus may be a site of synthesis of ribonucleic acid.

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Orientation of the Mitochondria during Mitosis

LITTLE is known concerning the behaviour of the mitochondria during cell division. Therefore we have studied the mitosis of cells from the tail of the pancreas in very young albino mice of the Danish State Serum Institute strain. The mice were three to eight days old (weight, 3–3½ gm.). For vital staining of the pancreatic cells the technique of Scott[1] was used. The carotids were clamped, a needle, wire gauge 26–27 (outer diameter, 0·5 mm.; inner diameter, 0·22 mm.), was introduced into the left ventricle of the heart, and Janus Green B solution 1/100,000 was injected at a pressure of 250–300 mm. mercury in the course of some fifteen minutes. The heart was contracting during the injection.

Half an hour before this procedure, 0·1 c.c. heparin solution (5 : 100) had been injected into the abdominal cavity.

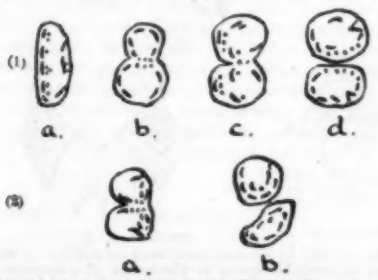
In 190 mice thus examined, only 51 mitoses were seen going on, including all phases of the division.

As soon as the injection has been finished, the pancreas was dissected out; this takes about five minutes, and a bit of the tail was pressed between a slide and a coverslip. The cells were observed at a magnification of 2,400 × (Zeiss, apochrom. *H I* 90, *K* 7 ×, binoc.) During the observation the preparation was kept at 20–22° C.

We tried to photograph the mitochondria, but did not obtain satisfactory pictures, possibly because proper film material was not at our disposal.

During all the phases of mitosis the mitochondria always move in such a manner that they are symmetrically arranged in relation to the plane of cleavage. This is seen from the drawings.

This finding is in accordance with the statistical observations reported by M. D. Thurlow[2,3], from whose work it seems probable that in mice all nerve cells contain the same number of mitochondria.



Mitochondria during mitosis: (1) Mitosis from prophase to telophase; (2) mitosis from anaphase to telophase

The symmetrical distribution of the mitochondria during mitosis indicates that they are of high importance to mitosis, and in their behaviour cannot but remind us of chromosomes during division.

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Feeding and Reproduction in the Pyramidellids

THE mode of life and relationships of the Pyramidellidæ have remained more obscure than those of any other group of the gastropods, though such aberrations as the presence of a radula, the hermaphrodite gonad and their suspected parasitic habit have aroused comment[1,2]. Pelseneer[1] described the feeding of *Brachystomia rissoides* (Hanley) = *Odostomia scalaris* Macg. which is parasitic on *Mytilus*: several individuals congregate on the edge of the shell of the mussel and each protrudes a long proboscis which is fixed to the inner surface of the mantle. No further details are given.

A similar association has now been established between five other species of pyramidellids and other animals, and the feeding process observed. *Odostomia eulimoides* Hanley lives on scallops, *Pecten* and *Chlamys*; *O. lukisii* Jeff., *O. plicata* Mont. and *O. unidentata* Mont. lurk among colonies of *Pomatoceros*, *Serpula* and *Spirorbis*; *Chrysallida spiralis* Mont. on those of *Sabellaria* spp., while it is known that *Turbonilla rufescens* Forbes is associated with a cœlenterate as yet unidentified. When the opportunity occurs, these molluscs extend a long proboscis and attach it to the body of their host—to the mantle of a lamellibranch, the tentacle of *Pomatoceros*, or, in the case of *C. spiralis*, it is thrust through the mouth of *Sabellaria* and fastened to the wall of the gut.

The gut is extremely specialized in connexion with this mode of feeding. There is a long introvert lined by a specialized epithelium, and when this is protruded it is found that the mouth is surrounded by a sucker by means of which the proboscis is fastened to the body of the host. Above the mouth, in the centre of the sucker, lies a second opening from which projects a long, hollow stylet which represents the fused jaws. Both mouth and stylet lead to a long, narrow tube, the modified buccal cavity, divided into two channels: the ventral, from the mouth, leads to a muscular pump; the dorsal contains the stylet into which run the ducts from the salivary glands. The sucker secures the proboscis to the prey; the body is pierced by the stylet, saliva may be used to loosen the tissue, and fluid, with perhaps loosened cells, is then sucked in through the mouth by the pump. The œsophagus is a long capillary tube leading to a simple stomach, and a short rectum passes to a mantle cavity, which contains many simplifications similar to those described in *Omalogyra*[4].

Each species of pyramidellid seems to restrict its feeding to one host. Were we to know these, then it appears that the collection and study of this little-known group would be greatly simplified.

Specialization also extends to the reproductive system, and of particular interest is the method of copulation, for this appears to be effected by an

invaginable tube which passes *through* the nerve ring ventral to the gut. The tube, together with its accompanying muscular pouch, is reminiscent of the copulatory apparatus of *Omalogyra*[4], which, however, is contained within the hermaphrodite duct and is not an independent structure. The eggs of *Odostomia* spp. are laid on their feeding grounds—on the shells of lamellibranchs or among the tubes of polychætes. A number of eggs are embedded in a copious supply of jelly[3] which binds them together and to the substratum, and which is produced by the hypertrophy of the upper part of the pallial oviduct during the female phase of these protandrous hermaphrodites.

The structure of the nervous system, gut and reproductive system may be shown to be consistent with the classification of the Pyramidellidæ as prosobranchs rather than opisthobranchs.

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Cotton Crop Yield in Relation to Application of Fertilizers

It is unfortunate that efforts to study the effect of various fertilizers on the cotton yield in Egypt have led to contradictory results. Thus Hughes[1], Prescott[2], and Khalil and co-workers[3] have reported that manuring has very little or no effect on the yield of cotton crop, while Mahmoud and Crowther[4,5,6] have shown that cotton produces better yield in response to nitrogen and phosphate applications, potash addition being without effect.

Several investigators[7,8,9] have found a correlation between the mineral composition of plant leaves, crop yield and fertilizer applications. We have carried out an experiment in which we have used foliar analysis of cotton (variety Menoufy) as an index to the nutrient conditions and crop yield of the plants. The soil plots that have been used in the present investigation are loamy in texture, situated in the farm of the Faculty of Agriculture, Fouad I University, at Giza, and have been under five controlled treatments since 1932. Each plot has seven replicates (9·20 × 8·20 m.) distributed according to the Latin square method.

The results seem to indicate that addition of any fertilizer gave better yield than that of plants grown in the completely unfertilized plots. It must be remembered, however, that the soil of the untreated plots has been without any fertilizer application since 1932; naturally such soil is rather spent. The plants that have been grown in plots supplied with full manure of phosphorus, potassium and nitrogen gave a higher yield than that obtained from plants given phosphorus and potassium but no nitrogen fertilizer. Non-addition of potassium or phosphorus fertilizer seems to have very little effect on the crop yield. The results have also shown that the Egyptian soil contains relatively large amounts of unavailable phosphorus and potassium, but little nitrogen; hence the need for addition of nitrogen fertilizer alone. We believe that the most suitable nitrogen fertilizer would be ammonium sulphate, because the ammonium–nitrogen will soon be transformed into nitrate by means of nitrifying and nitrating bacteria which are usually abundant in Egyptian soil fit for cultivation. In the meantime the sulphate ion will help to neutralize the alkalinity of the soil (the *p*H of the soil being usually about 8·0), and in doing so it renders available some of the naturally occurring unavailable phosphorus.

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F. Allam

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Giza. Jan. 22.

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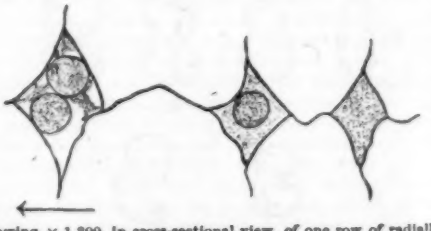
Intercellular Inclusions in White Mustard Roots Induced by Colchicine Treatment

During the course of an anatomical study of colchicine-induced hypertrophy in white mustard roots, attention has been given to some peculiar intercellular inclusions which are certainly not present in untreated roots. In this study, newly germinated seedlings are immersed in a 0·1 per cent colchicine solution for two hours, thoroughly washed in distilled water and then placed on moist filter paper to grow for a period of three days. At the end of this time, marked hypertrophy, characterized by stunted swollen root tips and an exceedingly dense development of root hairs, is obvious.

As already noted[1], rows of radially placed intercellular spaces occur at an early stage in the meristem of normal white mustard roots and are thought[2] to facilitate the more rapid movement of food materials to the surface cells. In hypertrophied root tips they are also conspicuous, but here they frequently contain a granular substance and spherical bodies which are comparable in size, stain reaction and general appearance to nuclei in adjacent cortical cells. Since the walls of the cortical cells forming the spaces are intact, the inclusions might be considered to be of the nature of tyloses or internal 'root hairs' growing from the cortical cells. Such an idea would fit in with the irregular swelling of the epidermal cells, marked increase in cellular volume of the cortex and the abnormal production of root hairs by the root



Drawing × 1,300, in cross-sectional view, of one row of radially arranged intercellular spaces in the cortex of a hypertrophied root, showing the intercellular inclusions. The arrow points to the outside of the root

cap cells. If the inclusions are tyloses they should be surrounded by cell walls of their own. The presence of a cell wall is still under investigation; but as soon as this has been decided, further data, including other abnormal features in these roots, will be published.

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Liberation of *nor*Adrenaline from Adrenal Medulla by Splanchnic Stimulation

THE active principle of the suprarenal medulla is commonly believed to be adrenaline. Holton[1] has recently shown, in this laboratory, that tumours of the medulla contain the non-methylated primary amine *nor*adrenaline in greater amount than adrenaline.

We have examined extracts of the suprarenal glands of dogs by determining the power of the extract to inhibit (*a*) the isolated rabbit intestine, and (*b*) the isolated rat uterus when stimulated by acetylcholine. The former test measures adrenaline plus *nor*adrenaline, the latter measures adrenaline only. We found that of five glands, two contained adrenaline only, while the active material in the other three was a mixture containing 14, 28 and 52 per cent *nor*adrenaline.

To find if *nor*adrenaline is actually liberated when the splanchnic nerve is stimulated, we have examined the effect of stimulating the splanchnic nerve in the cat. The experiments were carried out in spinal cats from which the viscera were removed and the kidneys excluded from the circulation. In these circumstances, splanchnic stimulation sent impulses to the suprarenal medulla only.

To distinguish between adrenaline and *nor*adrenaline, we used, in each experiment, the nictitating membranes of the same cat, one of which had been denervated not less than eight days previously by extirpation of the superior cervical ganglion. When an injection of adrenaline was made, the denervated membrane usually contracted more than the normal membrane, the mean value for the ratio of the size of the contractions being 1·6. When an injection of *nor*adrenaline was made, the ratio was, however, much greater, the mean value being 9·1. The ratios remained very nearly the same in any one experiment. When the splanchnic nerve was stimulated, the nictitating membranes contracted, and the ratio of the contractions indicated that the stimulation liberated a mixture of adrenaline and *nor*adrenaline. We were able to match the effect of splanchnic stimulation by the intravenous infusion of an equipressor mixture of adrenaline and *nor*adrenaline, and found that in different experiments the proportion of *nor*adrenaline varied from 20 (or less) to 80 per cent of the total active material secreted.

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Central and Peripheral Mechanisms in the Increase of Metabolic Rate; Mode of Action of Thyroxine

IT is sometimes difficult to decide whether an increase in metabolism is due to stimulation of the hypothalamic centres or to direct action on tissue respiration. Neither transection of the cervical spinal cord nor administration of barbiturates furnishes convincing evidence[1,2]. The former does not interfere with the nerve supply of the muscles of the head and the neck, nor with the connexions of the abdominal organs with the central nervous system through the vagi. Barbiturates may directly depress tissue respiration.

Morphine-scopolamine narcosis gives a more definite answer. This combination acts preferentially upon the hypothalamic centres without influencing tissue respiration. It does not decrease the basal metabolic rate of rabbits, nor does it affect the increase in the metabolic rate brought about by adrenaline or 2,4-dinitrophenol, the action of which is known to be peripheral[3,4]. On the other hand, it restores to normal values metabolic rates which have been increased by some central mechanism, as in the case of cooling the animal or administration of β-phenyl*iso*propylamine ('Benzedrine', 'Amphetamine').

If thyroxine is used to increase by 50 per cent the metabolic rate of rabbits, morphine-scopolamine has a depressing effect, although the rate cannot be restored to the normal value. Thus we conclude that, in the thyroxine effect on rabbits, a central as well as a peripheral mechanism is involved.

In birds, red blood-cells can be used for distinguishing between central and peripheral action upon metabolism. If the metabolism of ducks is raised by means of some action depending upon a central mechanism, such as cooling or subcutaneous administration of β-phenyl*iso*propylamine, there is no change in the oxygen consumption of these cells, which have no connexion with the nervous system, as measured on a suspension in the Warburg apparatus. On the other hand, adrenaline or dinitrophenol, administered subcutaneously, increases the *in vitro* respiration of the red cells. If we add blood plasma of an animal thus treated to a normal suspension of red cells, an increase in oxygen consumption of these cells ensues.

It has been found that after administration of thyroxine for four days, the respiration of the blood cells has increased to the same extent as the metabolic rate of the whole animal. Both effects fall off together. Blood plasma of a thyroxine-treated animal is unable to raise the oxygen consumption of a normal red blood-cell suspension. This may be explained by assuming that it takes some time for the thyroxine molecule to be built into the enzyme system of the cell. It is concluded that the metabolism-stimulating action of thyroxine in birds is entirely peripheral.

Detailed accounts of these investigations will appear elsewhere.

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Tubular Factors in the Development of Extra-renal Azotæmia

It is well known that in the mechanism of extra-renal azotæmia the causative factor is the loss of sodium and subsequent dehydration[1]. According to Gömöri and co-workers[2], the causes of dehydration-azotæmia are as follows: (1) blood pressure falls, and in consequence of the dehydration the colloid-oncotic pressure of the blood plasma increases, thus resulting in a drop of the glomerular filtration-rate; (2) circulation is slowing down, contributing thus to the diminished filtration-rate; (3) excessive rotein catabolism helps to aggravate the uræmic condition.

Some clinical observations, and the fact that during dehydration the concentrating power of the kidneys decreases, led us to investigate the role of the tubules during this condition.

Dehydration was developed in rabbits, by Darrow and Yannet's technique[3], of infusion to, and subsequent withdrawal of, an isotonic dextrose solution from the peritoneal cavity. Our results show clearly that: (1) in dehydration there is a significant decrease of the endogenous creatinin clearance (glomerular filtration-rate), but a still greater decrease of the urea clearance; in the control period, the ratio urea clearance/creatinin clearance was 0·68–0·87, whereas during dehydration it was 0·07–0·20; (2) this must be due to enhanced tubular re-absorption of urea; normally 20–40 per cent of the filtered urea was re-absorbed, but during dehydration it was as much as 80–90 per cent.

Thus it seems to be beyond doubt that in the development of dehydration-azotæmia, besides the hæmodynamic glomerular factors, a tubular factor plays its part too. The cause of the increased re-absorption of urea may be found in various factors. The known diffusibility of urea renders it especially liable to passive re diffusion. But it seems to be certain that the histological changes in the kidneys of dehydrated animals (Gömöri and Romhányi's[4] findings of medullary hyperæmia and tubular lesions in dehydration) make the tubules especially suited for re-diffusion. These histological changes were found in our experiments also.

Period	Interval (min.)	Urine flow (ml./min.)	Creatinin U/P	Creatinin Clear.	Urea clear.	Urea clear. Creatinin clear.	Serum NPN (mgm. %)
1	225	0·178	73	13·0	8·8	0·68*	26
2	524	0·136	33	4·5	1·8	0·40	40
3	1429	0·031	96	3·0	0·30	0·10	64
4	1964	0·045	16	0·7	0·07	0·10	90
5	2934	0·007	17	0·12	0·008	0·07	110
6	3390	0·091	12	1·1	0·22	0·20†	144
7	4319	0·131	19	2·5	0·45	0·18	164

* Before treatment. † Partial re-hydration with water.

In the table we give the results of one of our typical experiments. The ratio of urea to creatinin, expressing the tubular water re-absorption, emphasizes that the tubular re-absorption of urea is independent of the changes in water re-absorption, as well as being independent of the rate of urine flow.

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Effects of a Serum Injection after an Anti-Histaminic-Inhibited Shock

Pasteur, Vallery Radot, Halpen and Haltzer[1] assert that an anti-histaminic-inhibited shock has no tachiphylactic action; more precisely, rabbits protected from a shock by an anti-hystaminic died of shock after another dose of serum was administered some days later. They considered the results as an argument in favour of their theory, namely, that anti-histaminics prevent antigen-antibody reactions and thus leave the tissues free from antibodies to react with a subsequent dose of antigen. We have obtained contrary results, however, in analogous experiments. Thirteen guinea pigs have been sensitized with 1/10 c.c. of horse serum by intraperitoneal injection. After fifteen days they were given 1 c.c. of the same serum by intracardiac injection. Eleven were given 5 mgm. of an anti-histaminic ('Dimetina', kindly furnished by Le Petit Co.) by intraperitoneal injection 10 min. before the shock treatment. All of them survived, whereas the other two died.

These eleven guinea pigs were given next day another shock treatment with 1 c.c. of the same serum treatment by intracardiac injection. All of them survived. The weight of each guinea pig was about 300 gm.

Thus it seems that the anti-hystaminics do not inhibit the antigen-antibody reaction, and the latter disappears after an anti-histaminic-inhibited shock. This fact may be of considerable therapeutical value.

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Folic Acid as an Anti-anaphylactic

Ten guinea pigs (of medium weight, 350 gm.) were sensitized with 1/10 c.c. of horse serum by intraperitoneal injection. After fifteen days, two of them, used as controls, were given 1 c.c. of the same sensitizing serum directly into the heart; both died. Another guinea pig was given, intramuscularly, 15 mgm. of folic acid ten minutes before receiving the same dose of serum by intracardiac injection. This guinea pig also died of anaphylactic shock. Six others were given 30 mgm. of folic acid by intraperitoneal injection (to accelerate absorption), and the same serum treatment fifteen minutes later. All of them survived. Finally, the last guinea pig was given 15 mgm. of folic acid intraperitoneally and the same serum treatment after fifteen minutes. This one survived, too, but showed slight symptoms of shock.

These experiments show clearly a protective action of folic acid against the anaphylactic shock in guinea pigs. This action reveals itself after a certain time and using very large doses of folic acid. Thus it may be supposed that folic acid acts in macrocytic anæmia as an anti-anaphylactic and thus anti-histaminic. Assuming, as a pure hypothesis, that macrocytic anæmia may be due to an anaphylactic blockage of bone-marrow, especially as regards erythropoiesis, the successful results obtained with small doses of folic acid might be explained by a particular anti-anaphylactic action of this substance specific for normal erythropoiesis cells.

It may be remembered that agranulocytosis of Werner–Schultz, almost universally considered as a

"condition caused by an anaphylactic crisis of bone-marrow" (Bock[1]), has been cured with massive doses of folic acid by Gendel, Black and Stanbury[2]. The more spectacular results obtained in the treatment of macrocytic anæmia can be explained supposing that folic acid has much more specific action on the allergic blockage of erythropoietic tissue than on the allergic blockage of the leukopoietic one.

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Presence of Histamine in Central Nervous System Extracts

IT is well known that alcoholic or aqueous extracts of central nervous tissues (especially brain) lower the arterial blood pressure when injected intravenously into laboratory animals (dogs, cats, rabbits, etc.)[1,2,3]. The chemical agent, or agents, of the pressor effect, however, have not yet been identified; studies by Vincent *et al.*[3], Major and Weber[1] and more recently Kwiatkowski[4] having apparently discarded (or greatly minimized) the role of both histamine and choline in the pharmacological activity of the extracts. The object of this note is to present evidence that histamine is the main agent responsible for the depressor effect, and that central nervous system tissues, therefore, as well as many other tissues (liver, lung, skin, muscle, etc.)[5], contain histamine.

To detect histamine in the extracts, we have used (as recently suggested by Loew *et al.*[6]) the new anti-histamine drug benadryl, which in the dog inhibits almost specifically the action of histamine on the arterial blood pressure, approaching the degree of specificity displayed by atropine against acetylcholine. Therefore we tested in *dogs* the action of both benadryl and atropine on the effect of the extracts, and found that benadryl reduced in the same degree the depressor responses both to the extracts and to small doses of histamine, whereas atropine (in agreement with the results of earlier workers[1,3]) left unmodified the depressor response to the former.

The accompanying table summarizes the results of a typical experiment, the extracts having been prepared from ox, sheep, dog or rabbit brain, as follows. The fresh nervous tissue was minced, mixed with twice its volume of 96 per cent ethanol and left (with frequent stirring) either at 20° or in the cold for 4–20 hours. The suspension was then pressed through a thin cloth, and the brain matter extracted once more in the same way. First and second filtrates were collected and evaporated *in vacuo* below 50°; the residue was spun off and the bulky precipitate of denatured proteins and lipids discarded (supernatant: extract *A*). Extract *B* (from ex. *A*) and extract B_1 are the same as extract *A* but treated with basic lead acetate until no more precipitate was formed, centrifuged to eliminate the precipitate, and the lead from the supernatant removed by precipitation with sulphate and centrifugation. After neutralization, the activity of the extracts was tested by injection into the femoral vein of dogs anæsthetized with pentobarbitone, blood-pressure records being taken from the carotid artery. The histamine equivalent of the extracts was determined by comparing the effect on the arterial blood pressure of different concentrations of extract with similarly different concentrations of histamine solutions.

Similar results are obtained with acetone or trichloroacetic[7] extracts of brain. Extractions of the nervous tissues with ethyl ether did not yield active preparations. The extracts, after purification with basic lead acetate, which does not remove the depressor activity (contrary to the findings of Major and Weber[1]) were further fractionated by following the main lines of the procedure described by Best *et al.*[8]. The activity was carried down in both precipitations with phosphotungstic acid and silver-barium hydroxide, the depressor effect of the active fractions, as well as that of the original extract, being inhibited by benadryl.

	Histamine equivalent of the extracts (μgm./ml.)	gm. tissue / ml. extract	μgm. histamine / gm. tissue	Inhibition of the depressor responses by: benadryl (1 mgm./kgm.)	Inhibition of the depressor responses by: atropine (0·1 mgm./kgm.)
Extract *A* (0·09 ml.)	45	2·6	17·3	26 per cent	0 per cent
Extract *B* (0·125 ml.)	32	2·0	16·0	25 ,,	0 ,,
Equivalent histamine, 4 μgm.	—	—	—	24 ,, (3 mgm./kgm.)	—
Extract B_1 (0·23 ml.)	43	4·4	9·8	67 per cent	—
Equivalent histamine, 10 μgm.	—	—	—	71 ,,	—

Full details of this work will be published elsewhere. We are indebted to Dr. J. J. Izquierdo for measuring the potency of some of our extracts.

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Isolation from Acid-Fast Bacteria of a Growth-Factor for *Mycobacterium johnei* and of a Precursor of Phthiocol

Mycobacterium johnei will not grow on plain egg medium; but Twort and Ingraham[1] demonstrated that good growth could be ensured by the addition of acid-fast bacteria or products extracted from them with organic solvents. Egg medium containing 1 per cent dried *Myco. johnei* has been used for many years to cultivate the organism.

We have now isolated from *Myco. phlei* a compound capable of promoting vigorous growth of

Myco. johnei on egg medium. This new growth-factor has been obtained crystalline in the form of a colourless aluminium derivative, melting point 218° (found: C, 63·45; H, 7·9; Al, 3·0 per cent; figures for nitrogen were inaccurate owing to formation of aluminium nitride during combustion). The corresponding metal-free product has been isolated only as an amorphous powder of melting point 170° (found: C, 65·1; H, 8·55; N, 9·0 per cent; optical rotation, $(\alpha)_D^{22} - 16°$, $C = 3·2$, chloroform). The absorption spectra in methanol show the following characteristics. Metal-free material: max. 250 and 310 mμ, $E^{1\%}_{1\,cm}$ 158 and 42. Aluminium derivative: max. 263 and 342 mμ, $E^{1\%}_{1\,cm}$ 204 and 58. From the evidence available at present, we believe the approximate formula of the aluminium derivative of the factor to be $C_{42}H_{73}O_{10}N_4Al$.

Woolley and McCarter[2] reported that vitamin K concentrates, phthiocol (2-methyl, 3-hydroxy, 1-4 naphthoquinone) and other naphthoquinone derivatives promoted the growth of *Myco. johnei* on liquid medium, though these anti-hæmorrhagic compounds were less effective than cells of *Myco. phlei*, which they believed to supply some other factor also required for optimal growth.

We believe our growth-factor to be quite unrelated to the naphthoquinones, and using solid egg medium we have been unable to confirm the growth-promoting effect of phthiocol reported by Woolley and McCarter. Moreover, we have now isolated from *Myco. tuberculosis* a product resembling the known K vitamins, and have found that it also fails to promote the growth of *Myco. johnei*.

This compound has been isolated as a yellow oil which appears to be chromatographically homogeneous, but has yielded no crystalline derivative (found: C, 85·1, 85·15, 85·05; H, 10·1, 10·45, 10·25 per cent; molecular weight, cryoscopically in benzene, 688, 706, 691; refractive index $n_D^{22} = 1·5286$; hydrogenation (Adams's catalyst) 316 c.c. hydrogen at N.T.P. absorbed per gm. The absorption spectrum in hexane is identical in shape and in the relative heights of the peaks with the spectra of vitamins K_1 and K_2, though the absolute height of the peaks is lower than either.

Quinone from *Myco. tuberculosis*		Vitamin K_1[5]	
max. (mμ)	$E^{1\%}_{1\,cm.}$	max. (mμ)	$E^{1\%}_{1\,cm.}$
242·5	227	243	287
248	241	249	305
260·5	220	260	275
269	216	270	275
325	41	325	53

The absorption coefficient is in agreement with the finding that this compound has a molecular weight greater than that of vitamin K_2 ($C_{41}H_{56}O_2$, mol. wt. 580), presumably due to the presence of a longer side-chain.

This oil yields phthiocol on alkaline hydrolysis, and appears to be the source of the phthiocol which was isolated from extracts of *Myco. tuberculosis* by Anderson and Newman[4]. The possibility that phthiocol might arise from vitamin K was first suggested by Fieser *et al.*[5]. We have failed to detect any free phthiocol in fresh extracts of *Myco. tuberculosis*, and a similar finding has been reported by Parschin[6]. Extracts which have been allowed to stand for some weeks are found to contain phthiocol, and this probably explains the observation of Crowder *et al.*[7], who reported the presence of both free and combined phthiocol in an unhydrolysed extract of *Myco. tuberculosis*.

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Absolute Cross-sections for the Capture of Neutrons of 200 and 900 keV. Energy

Knowledge concerning compound nuclei can be derived mainly from two groups of experiments. The study of individual levels yields information as to the values that the total and partial widths can assume. Where in one nucleus several neighbouring levels can be observed separately, individual level distances can be determined. A great number of measurements of this second type have been made. They show that level-widths and -distances vary over a considerable range.

The distance between levels, however, becomes so small with increasing excitation energy that it would seem hopeless to derive all information only from observations of separated levels. But the observation of average values of widths and distances—particularly if known as a function of the excitation energy—can in this case be considered as a description of the compound nucleus as a whole.

Bethe and Placzek[1] have shown that the average cross-section for the capture of neutrons with zero angular momentum taken over many levels is

$$\bar{\sigma} = \frac{\lambda^2}{2\pi} \cdot \left(\overline{\frac{\Gamma_n}{D} \cdot \frac{\Gamma_\gamma}{\Gamma_n + \Gamma_\gamma}}\right),$$

where λ is the de Broglie wave-length of the neutron; Γ_γ the radiation width; Γ_n the neutron width and D the level-distance. Γ_n/D is the sticking probability. For low neutron energies ($< 500{,}000$ eV.) $\Gamma_n < \Gamma_\gamma$, and therefore

$$\overline{\sigma_{cap}} = \frac{\lambda^2}{2\pi} \frac{\overline{\Gamma_n}}{D}.$$

Above 1 MeV., $\Gamma_\gamma/(\Gamma_n+\Gamma_\gamma)$ decreases rapidly with energy.

A number of theoretical attempts have been made to determine the value of $\frac{\Gamma_n}{D} \cdot \frac{\Gamma_\gamma}{\Gamma_n + \Gamma_\gamma}$. Qualitative considerations of Bohr's theory of the compound nucleus predict a continuous increase with increasing mass number. The quantitative theories of Bethe,

Peierls and Kapur[2], and more recently Feshbach, Peaslee and Weisskopf[3], again show a monotonic increase of σ with mass number.

Determinations of $\overline{\sigma_{cap}}$ should be made with neutron sources with a spread in energy distributions which is small compared to the mean energy but big compared to $\overline{D}$, the mean level-distance, so that the experimental result is a mean over many levels. (This is, for example, the case for the photo-neutrons produced by radiothorium in heavy hydrogen ($E = 200 \pm 28$ keV.) and beryllium ($E = 900 \pm 13$ keV.), and also for D—D sources, with certain precautions as to target thickness and angular distribution.)

Measurements of this kind have already been made[4]. They all show that $\overline{\sigma_{cap}}$ does not vary monotonically with the mass of the compound nucleus formed by the capture of the neutrons. In these circumstances, it seemed desirable to repeat the measurements with all possible precautions, avoiding slowing down of neutrons in the source and by the surroundings and also taking into account new data obtained for the absorption coefficients of β-rays.

The capture cross-sections of the elements for 900-keV. neutrons were measured in the following way. The cross-section for manganese was determined absolutely by irradiating a manganese sulphate solution with a radiothorium–beryllium photo-source, under conditions in which it is possible to calculate the fraction of all neutrons captured by the manganese. The radioactive manganese is precipitated from part of the solution and its β-activity measured on a Geiger–Müller counter. The same precipitated powder is then irradiated by the photo-source in air, and its β-activity again measured. The absolute cross-section of neutron capture can be calculated directly from the ratio of the two counts and the ratio of capture cross-section of manganese to hydrogen for thermal neutrons; it is not necessary to know the absolute neutron flux or the β-counting efficiency of the Geiger–Müller counter.

The cross-sections for the other elements were then determined by measuring the ratio of their β-activities to that of the manganese when irradiated by the photo-source in air, and also the ratio of the self-absorption of their β-rays to the β-rays of manganese. The cross-sections for 200-keV. neutrons were obtained directly by using these results in conjunction with those of Allen and others[5], who found the ratio of the cross-sections for 900 and 200-keV. neutrons. The results are given in the accompanying table.

Isotopic cross-sections (millibarns)

	$^{28}Al_{13}$	$^{55}Mn_{25}$	$^{63}Cu_{29}$	$^{75}As_{33}$	$^{107,109}Pd_{46}$
σ 900	2·05 ± 0·7	7·2 ± 0·7	8·8 ± 1·8	81 ± 7	214 ± 50
σ 200	3·5 ± 1·4	15·6 ± 4	11·4 ± 3	300 + 40	430 ± 140
	$^{111}Pd_{46}$	$^{109}Ag_{47}$	$^{115}In_{49}$	$^{123}Sb_{51}$	$^{127}I_{53}$
σ 900	131 ± 50	370 ± 70	650 ± 110	156 ± 80	180 ± 30
σ 200	146 ± 70	740 ± 160	525 ± 120	185 ± 50	300 ± 60
			54 min.		
	$^{130}Ba_{56}$	$^{121}Te_{52}$	$^{187}W_{74}$	$^{197}Pt_{78}$	$^{198}Au_{79}$
σ 900	4·3 ± 2	26·5 ± 8	42 ± 7	480 ± 230	490 ± 80
σ 200	8·1 ± 4·3	34 ± 17	60·5 ± 19	1170 ± 600	490 ± 120

Clearly the cross-sections of nuclei of comparable mass number show considerable differences. This is most striking for antimony, tellurium, iodine and barium. Very low cross-sections for bismuth and lead[2] have been found by other authors. It is also obvious that the general tendency of the cross-sections to increase with increasing mass number is not very marked.

It was pointed out by Halban and Kowarski[4] that these selectivities might be due to the strong dependence of $\overline{\sigma_{cap}}$ on the binding energy, which is known to vary between 6·5 and 10 MeV. in the case of the formation of active nuclei. It is, of course, true that the comparisons of different nuclei would be of more significance if they could be made for constant excitation energy (that is, binding energy + kinetic energy of the captured neutron). It would, however, be experimentally very difficult to compensate the great differences in binding energy by using neutrons of different energy. In any event, such comparisons are not very significant, as with increasing neutron energy, other effects, such as inelastic scattering of neutrons, n—$2n$ reactions, as well as the contributions of neutrons of high angular momentum, become important.

In the meantime, however, a number of binding energies have become known through the determination of the energy liberated in (d,p) reactions. Although they do not yet give information about nuclei heavier than arsenic, they show that no direct link between binding energy and $\overline{\sigma_{cap}}$ can be established. A similar impression is conveyed by the results of Allen and others[5], who determined the ratio of $\overline{\sigma_{cap}}$ for neutrons of 900–220 keV. for twenty-three elements.

There seems, therefore, little doubt that we are faced with a contradiction between existing qualitative and quantitative theories on one hand, and experimental facts on the other. While it might be argued that there are only a few nuclei which show these marked deviations from the general trend of $\overline{\sigma_{cap}}$, existing theories do not allow for such variations.

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H. H. Halban

Clarendon Laboratory,
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Oct. 11.

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[3] Feshbach, Peaslee and Weisskopf, *Phys. Rev.*, **71**, No. 3, 145 (1947).
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[5] Allen, B., Bishop, G., Demers, P., and Halban, H., *Nature*, **161**, 727 (1948).

Particles with Spin and the Principle of Reciprocity

Following a suggestion of Prof. Max Born and Dr. H. S. Green, we have extended their theory of ultimate particles, recently published in *Nature*[1], to the case of spin $\frac{1}{2}$.

The metric operator, which in the case of spin 0 or 1 was $S = x^k x_k + p^k p_k$, is now

$$S = (p^k + i\gamma x^k)\alpha_k, \qquad (1)$$

where α_k ($k = 1, 2, 3, 4$) is a set of Dirac matrices and $\gamma = \alpha_1\alpha_2\alpha_3\alpha_4$. Its reciprocal property is expressed by the equation

$$S(x_k, p_k) = T^{-1} S(p_k, -x_k)T, \qquad (2)$$

where $T = \frac{1+i\gamma}{1+i}$, and one obtains all self-reciprocal

functions as solutions of the equation

$$S\mathbf{F} = \mathbf{F}s, \qquad (3)$$

where s is an eigen-symbol depending only on γ.

These solutions can again be expressed in terms of Laguerre polynomials $L_n^k(P)$, where $P = p_\mu p^\mu$;[3] it is convenient to write them separately for the two eigen-values ± 1 of γ, namely,

$$\mathbf{F}_1 = 2\{(\alpha_r p^r)\, L_n^{k+2}(P) \pm \sqrt{n-k-1}\, L_n^{k+1}(P)\} (\alpha_r p^r) k e^{-P/2} g, \qquad (4)$$

$$\mathbf{F}_2 = 2\{(\alpha_r p^r)\,[L_n^{k+1}(P) - L_n^{k+2}(P)] \pm \sqrt{n+1}\, L_n^{k+1}(P)\}(\alpha_r p^r) k e^{-P/2} g, \qquad (5)$$

where g is a three-dimensional spherical function depending on the direction of the 4-vector p_r; n has the values 1, 2, 3, . . ., while $k = 0, 1, 2, \ldots n-1$.

The roots of the equations $\mathbf{F}_1 = 0$, $\mathbf{F}_2 = 0$ are as before, the mass factors $\varkappa^2$ from which the real masses are obtained:

$$\mu = \frac{\hbar\varkappa}{ca}, \quad \text{and with } a = \frac{e^2}{mc^2}$$

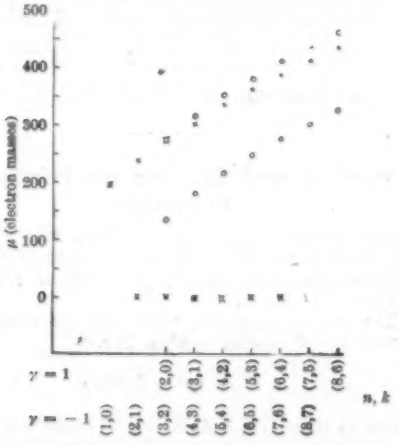
one has $\frac{\mu}{m} = \frac{\hbar c}{e^2}\varkappa = 137\varkappa$. Following Born and Green, we shall regard m as the mass of the electron.

As the expressions (4) and (5) have both the factor $(\alpha_r p^r)^k$, it follows that for odd $k > 1$ the theory predicts the existence of neutrinos satisfying

$$\alpha_r p^r = 0. \qquad (6)$$

As already said in the previous communications, it seems to be very likely that the same factor represents electrons as charged neutrinos, the finite mass of which is due to the self-energy of the electromagnetic field produced by the charge. A preliminary proof of this has been given by Dr. Green.

For even k, one has particles satisfying the same equation as photons, $(\alpha_r p^r)^2 = p_\mu p^\mu = P = 0$, but with different spin properties.



Then there are a great many other particles, mesons with spin $\frac{1}{2}$, the masses of which are obtained by putting the brackets in the expressions (4) and (5) equal to zero and solving for P. The values of $\varkappa$ for these are given in the accompanying table, and the rest-masses represented in the diagram.

For $\gamma = 1, k = n-2$		For $\gamma = -1, k = n-1$	
n		n	
2	1	1	1·41
	2	2	0
3	0		1·73
	1·30	3	0
	2·30		2
4	0	4	2·23
	1·56		2·23
	2·56	5	0
5	0		2·45
	1·79	6	0
	2·79		2·64
6	0		
	2		
	3		

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Thermal Conductivity of Superconductors

MEASUREMENTS have recently been made in this Laboratory of the specific thermal conductivity at liquid helium temperatures of a series of tin specimens, ranging from spectroscopically pure tin to alloys containing up to 4 per cent of mercury. A tantalum specimen was also measured. The apparatus was based upon the design of de Haas and Rademakers[1], with a pair of gas thermometers measuring the temperature at two points on a rod carrying a known heat power. An innovation was the use of the thermometers differentially, the pressure difference being indicated on a butyl phthalate oil manometer read with a travelling microscope. A much finer resolution was possible than in previous work[1,2], thus enabling accurate measurements of thermal conductivity to be made with temperature differences of only 0·01° K. Consequently a careful survey could be made of the

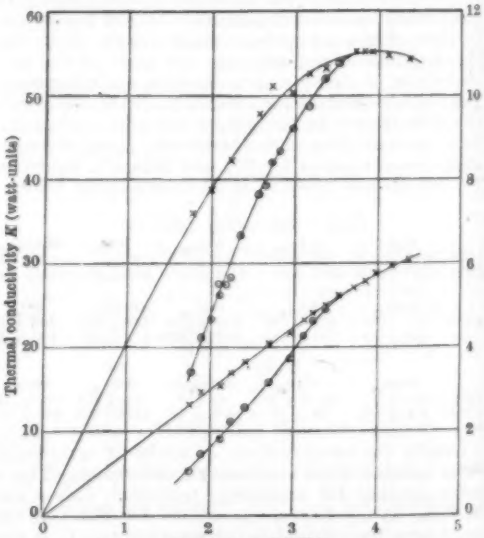

Fig. 1. Left-hand scale and upper curves, Sn2. Right-hand scale and lower curves, Sn3. ×, Normal curve; ⊙, superconducting curve

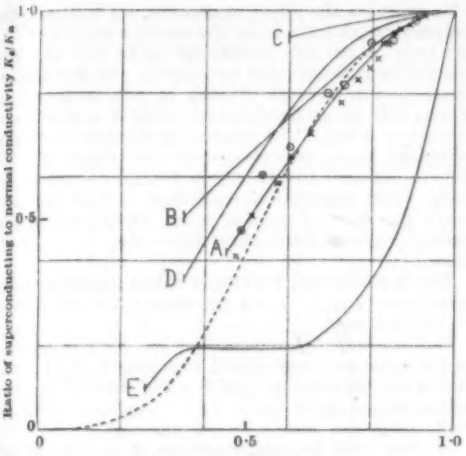

Fig. 2. Curve *A*, ○ Sn2, 0·003 per cent impurity, K_n = 55·3 at T_c; × Sn3, 0·033 per cent mercury, K_n = 5·49 at T_c.
Curve *B*, Sn6, 0·33 per cent mercury, $K_n = 0{\cdot}628$ at T_c.
Curve *C*, Sn9, 4·1 per cent mercury, $K_n = 0{\cdot}124$ at T_c.
Curve *D*, tantalum, $K_n = 0{\cdot}0501$ at T_c.
Curve *E*, lead, $K_n = 4{\cdot}28$ at T_c (ref. 1).
Dotted curve, Heisenberg theory.
(The experimental points are omitted from curves *B*, *C* and *D*, the scatter being of the same order as for Sn2 and Sn3)

region close to the superconducting transition temperature. The thermal conductivity was measured in both superconducting and normal state, the latter by destroying superconductivity with a longitudinal magnetic field. In the case of very pure tin, the magnetic field produced a large variation of conductivity in the normal state, and extrapolation was necessary to derive the value in zero field.

Typical conductivity-temperature curves are shown in Fig. 1 for spectroscopically pure tin (Sn2) and tin containing 0·033 per cent of added mercury (Sn3). According to Makinson[3], the electronic thermal resistance of a pure metal may be expressed as the sum of lattice vibration scattering and impurity scattering terms, $\alpha T^2 + (\beta/T)$, and this formula was found to represent the results for the normal state quite well. The initial slope of the conductivity curves gave values of β in good agreement with the theoretically predicted values ρ_0/L_0, where ρ_0 is the residual electrical resistance and L_0 the Lorenz number.

The ratio of superconducting to normal conductivity is plotted in Fig. 2 as a function of the reduced temperature T/T_c, where T_c is the transition temperature. No discontinuity is apparent in the curve or its gradient at the transition point, but the values of K_s/K_n for Sn2 and Sn3 fall on a single curve, in spite of the very large difference in the absolute values of their conductivities; this suggests that the ratio may be a characteristic function of temperature. It is interesting to note that a universal function of this kind proposed by Heisenberg[4] and shown dotted in Fig. 2 is in fair agreement with the experimental data.

On the basis of this concept, the departures for the less pure specimens Sn6 and Sn9 from the curve for Sn2 and Sn3 may be interpreted as due to the additional heat transport through the ionic lattice itself, which may reasonably be assumed to be independent of whether the metal is superconducting or normal. This additional contribution would naturally become important for specimens in which the low purity gives rise to a low electronic conductivity; on the assumption that the ratio of the superconducting to normal electronic conductivities is given by the Sn2 and Sn3 curve, a new method of estimating the lattice conductivity is provided, the values so obtained for Sn6 and Sn9 being consistent and of a reasonable order of magnitude.

The tantalum specimen shows the same general behaviour as tin, but the curve of K_s/K_n departs somewhat from the curve for pure tin. If, as suggested above, there is a universal curve for K_s/K_n as a function of reduced temperature which applies to all superconductors, the difference between the tantalum and pure tin curves can probably be attributed, as in Sn6 and Sn9, to heat transfer by the lattice itself.

The K_s/K_n curve for lead[1] is also shown in Fig. 2 and does not contradict the idea of a universal ratio curve if this is assumed to apply only to impurity scattering (responsible for the β/T term in Makinson's expression for the normal conductivity). Comparison of Makinson's formula with the normal curve for lead indicates that lattice vibration scattering (responsible for the αT^2 term) is predominant except at the lowest temperatures. The abnormally low values of K_s/K_n at higher temperatures may perhaps be interpreted as indicating that scattering of electrons by lattice vibrations is much more effective in the superconducting than in the normal state. The K_s/K_n values for lead are roughly in agreement with the Heisenberg curve at the lowest temperatures where impurity scattering is the main process.

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Jan. 13.

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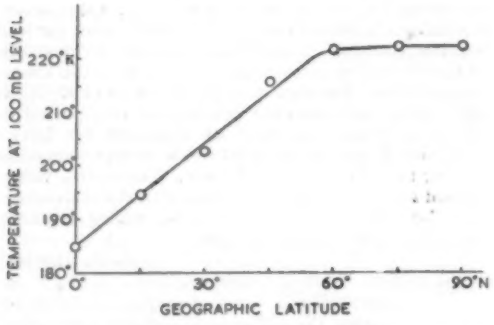
Latitude Effect and Pressure-Level of Meson Formation

Kupferberg[1] first, and later on Rathgeber[2], have both directed attention to the possibility that the latitude effect of cosmic rays due to the geomagnetic field may be partially masked by the fact that the height of the pressure-level of meson formation increases towards the equator. In particular, Rathgeber has shown, by taking 100 mb. for this pressure-level, that owing to this increase, the intensity of mesons at sea-level at mean latitudes should exceed the intensity at the equator by 3 per cent. The magnetic latitude effect would therefore be reduced from 10 to 7 per cent.

I wish to point out that a further correction must be applied as a consequence of the increase with latitude of the temperature at the level of meson production. I reported at the Bristol Symposium on Cosmic Radiation last September that the temperature at this level, or its equivalent the density, appears to be a factor closely controlling the meson intensity at sea-level. The intensity at sea-level increases with increasing temperature or decreasing density at the rate of 0·11 per cent per ° C., that is,

at the rate of about − 0·22 per cent for a change of air density at the region of production of 1·0 per cent. Further measurements made in the last two months have entirely confirmed the reality of this result. A detailed account of this will appear elsewhere. Since the temperature at the 100 mb.-level increases with latitude, we may expect, therefore, a greater intensity at sea-level of μ-mesons in mean latitudes than in the equatorial region. The accompanying figure gives the annual mean temperature of the 100 mb.-level, as obtained from the vertical distribution of temperature in summer and winter, according to Haurwitz and Austin[3]. It will be seen that the difference in temperature between the plateau above lat. 60° and the value at the equator amounts to about 36° K. This difference, multiplied by the coefficient 0·11 per cent given above, leads us to expect that the intensity of mesons would increase from the equator to latitude 60° by 4 per cent. Allowing for this increase, as well as that obtained by Rathgeber, the magnetic latitude effect would, therefore, be reduced to the small value of 3 per cent.



We may note, however, that in making these corrections it has been assumed that the mesons are formed at the same pressure-level in all latitudes. This seems to be the general belief, but it has not yet been proved. Indirect evidence that the bulk of the penetrating component is formed in the proximity of the 100 mb.-level in mean latitudes has been given[4], but no evidence exists, so far as we know, that this is so in the equatorial region. On the other hand, if mesons are produced by primary protons, it is plausible to expect that the region of production lies at greater depths at the equator, since the incident proton will have a greater energy at the equator and so may penetrate deeper into the atmosphere than those at higher latitudes, which will be of lower energy.

If, therefore, we assume that the mesons are formed at a pressure-level lower than 100 mb. near the equator, it may be seen that the atmospheric effects under consideration would result in the two corrections being opposite in sign.

Let us assume, for example, that the production-level at the equator is at 125 mb. From meteorological observations, the mean height of this pressure-level appears to be 15·1 km., while that of 100 mb. at lat. 45° is 16·1 km. Neglecting the change in energy spectrum, the difference in intensity due to decay of ordinary mesons would be given with sufficient approximation by the ratio of the difference in height to the mean range L. Thus, with the value 18·6 km. formerly found for L, $I_{45°} - I_{Eq.} = (15·1 - 16·1)/18·6 = -5·4$ per cent.

To estimate the effect of density, we will take the temperature at 125 mb. at the equator to be 196° K., and that at 100 mb. at lat. 45° to be 215° K. The relative densities at the two levels will be proportional to the pressure divided by the temperature, and so will be proportional to $100/215 = 0·465$ and $125/196 = 0·638$. The relative difference in density, expressed as a percentage of the mean will be $200\ (0·465 - 0·638)/(0·465 + 0·638) = -31·4$ per cent. With the density coefficient − 0·22 per cent per 1 per cent of density given above, we should have on account of this effect $I_{45°} - I_{Eq.} = +6·9$ per cent.

The two atmospheric effects taken together would give $I_{45°} - I_{Eq.} = -5·4$ per cent + 6·9 per cent = + 1·5 per cent.

Had we assumed 150 mb. for the production-level in the equatorial region and so a height of 14·2 km. and a temperature of 205° K., the sum of the two effects would have given $I_{45°} - I_{Eq} = -10·2$ per cent + 9·8 per cent = − 0·4 per cent.

It may well happen, therefore, that the latitude effect as observed at sea-level is almost entirely due to the deflecting action of the geomagnetic field, owing to the accidental cancelling of the corrections due to the height and to the temperature of the production level. It will only be possible, however, to determine accurately the magnetic latitude effect when the variation of the height of the level of formation with latitude has been determined.

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Jan. 21.

[1] Kupferberg, K. M., *Phys. Rev.*, **73**, 804 (1948).
[2] Rathgeber, H. D., *Nature*, **162**, 303 (1948).
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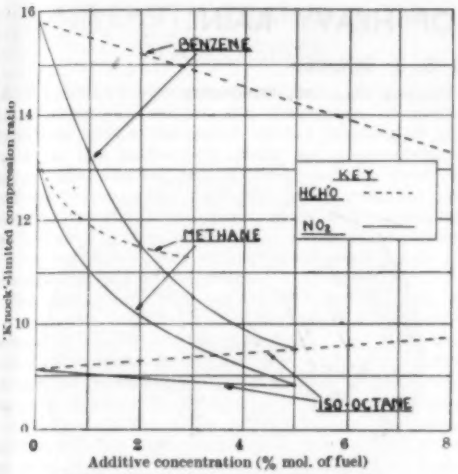
'Knock' in Internal Combustion Engines

Work on the effect of additives on the 'knock'-limited compression ratios of a wide variety of fuels has shown that there are at least two mechanisms whereby a fuel may 'knock'. One appears to correspond to the 'high'- and one to the 'low'-temperature ignition process discovered[1] and thoroughly explored[2] by Townend and his co-workers. Hydrocarbons such as benzene and methane, which Townend did not observe to give a 'low'-temperature ignition peninsula, 'knock' by the 'high'-temperature process, and other hydrocarbons 'knock' by the 'low'-temperature process.

Using a Ricardo E.6 variable-compression engine, we have obtained curves of 'knock'-limited compression ratio (determined aurally) against concentration of additive. In the course of work with a very large number of additives (the full results of which will be published elsewhere) we have found that in benzene and methane, formaldehyde and nitrogen peroxide are strong pro-knocks, whereas in *iso*-octane, formaldehyde is an anti-knock and nitrogen peroxide has only a very slight pro-knock effect (see diagram). The differential effects of these dopes in the two classes of hydrocarbon correlate well with their effect on the 'high'- and 'low'-temperature modes of oxidation respectively[3,4]. The effect of these additives in hydrogen is similar to their effect in benzene and methane.



Tests on formaldehyde and nitrogen peroxide

In addition, we have found that both methane and hydrogen have considerable lead responses. The latter result differs from that of Egerton, Smith and Ubbelohde[4], who found tetraethyl lead to have no effect in hydrogen. It may be that the results of Egerton *et al.* were complicated by the incidence of pre-ignition, which is difficult to exclude when working with hydrogen.

This work was carried out in the Ricardo Laboratory on behalf of the Shell Petroleum Co.

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Cambridge.

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[2] See Newitt and Townend, "The Science of Petroleum", **4**, 2884, 2958 (1938).
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[4] Townend, *Chem. Rev.*, **21**, 259 (1937).
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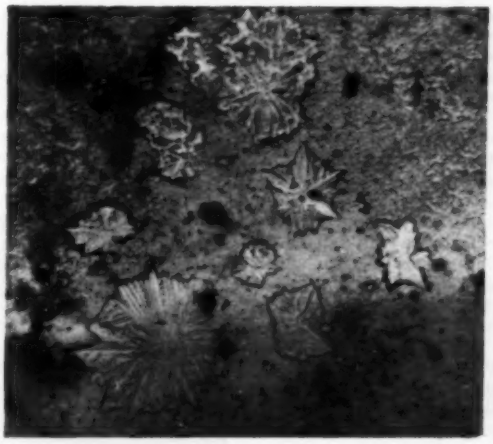
Hydrolysis of Starch Grains by Polarized Infra-Red Radiation

At the Liverpool meeting of the British Association in 1923, it was shown that polarized radiation had the effect of accelerating the change of starch grains, in a *weak* suspension of diastase and at ordinary laboratory temperature, into a crystalline reducing substance; but if the diastase were active or concentrated, no *selective* effect was observed[1]. Earlier experiments in 1922 had shown me that, when ground cereals in plain tap water were exposed to this radiation, a portion of the starch was turned to sugar. This was estimated by Bertrand's method[2]. To meet criticism that the effect might be due to the pressure of the cover glass, the experiment was repeated; but instead of using a microscope slide, the starch suspension was in a flat-bottomed, very thin-walled flask, the base of which was irradiated by light, polarized and reflected vertically upward by a suspension of diastase in an *outer* vessel[3].

The resulting hydrolysis was so remarkable that, not only did it dispose of the cover-glass theory, but also it suggested that the polarization of the incident radiant energy by the diastase was the important *physical* factor in enzymatic hydrolysing action; for the enzyme was not in contact with the substrate.

Hydrolysis without enzyme. Prof. E. C. C. Baly pointed out to me that the absorption bands, both of water and the carbohydrate groups, were in the short infra-red. Fused silica ('Vitreosil') dishes, which transmit these rays, have now been used. Radiation from an electric spiral or small radiator was reflected by black glass or by ferrotype at the polarizing angle, striking the underside of the dish containing a suspension of well-washed potato-starch grains. After a period of about seven hours, the grains in some places had a dull, swollen appearance. On drying, clusters of crystals were seen exuding from the grains, or totally escaped into the surrounding medium (see photograph). The temperature was usually only one, or sometimes two, degrees above the room temperature (generally about 19° C.).



The addition in later experiments of a trace of sodium chloride (0–0·3 per cent) greatly increased the effect. In this case, the crystals often formed *within* the grain, the coat of the grain gradually disappearing. The sodium chloride apparently acted as a co-enzyme.

The contents of the dish were washed out with distilled water, and, when tested in the usual way, gave evidence of sucrose.

If the experiment is done during the months when the potato tubers are in a dormant condition, the control, placed by the side with ordinary radiation, gives intact starch grains; but after February some crystals may be found and a few of the grains will be seen breaking.

The similarity of the results, though in a much smaller degree, indicates that in this experiment we are imitating the natural process of enzyme hydrolysis.

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[1] *Nature*, **111**, 49 (1923).
[2] *Chemistry and Industry* (Oct. 5, 1923). Baly and Semmens, *Proc. Roy. Soc.*, B, **97**, 250 (1924). *Nature*, **134**, 813 (1934).
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RADAR OBSERVATION OF HEAVY RAIN

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WHILE a certain amount of data on radar observations of tropical rain has been published, the accompanying photographs of a radar P.P.I. screen showing a belt of heavy rain passing over the Manchester district may be of interest. The wavelength used was 3 cm. and the pulse length 1 microsecond, the photographs being taken on the afternoon of Friday, November 19, 1948, approximate times only being given.

Fig. 1 is a tracing of the P.P.I. picture with the coast-line and certain known points plotted by range and bearing for identification purposes. The radius of the display is about 40 miles.

Fig. 2 is a photograph, taken at 2.50 p.m., showing a belt of rain more than 30 miles long forming in the west.

Fig. 3 was taken at 3.30 p.m. Note how the rain is moving to the east, giving very strong echoes, the belt being continuous for more than 50 miles. Although not very obvious in the photograph, the centre of this belt is curved backwards, presumably being delayed by the high ground in the Wigan area.

Fig. 4 was taken at 4.20 p.m. The rain belt has passed over Manchester and is much shorter. Note the secondary belt of rain following the main one, and the apparent attenuation of the normally strong echo from the hill (Mow Cop) just south of Congleton, possibly due to the two rain belts across this path.

Fig. 5 was taken at 4.35. The belt has lengthened slightly and the centre is again delayed, possibly due to the high land in the Peak District. A further photograph was taken at 4.45 p.m., which showed that the rain had passed the Peak and appeared to be weaker; this may be due to the masking effect of the hills as the rain passes below the horizon.

The general speckled background in most of the photographs is the effect of receiver noise in the radar system.

The echoes received are from very heavy rain. The observed belt arrived in Manchester a little before 4 p.m. and was preceded by about five miles of light rain. At this period, Ringway Airport reported that 4 mm. of rain fell in 35 minutes. Light rain persisted for more than an hour after the heavy rain passed over.

Fig. 1

Fig. 2

Fig. 3

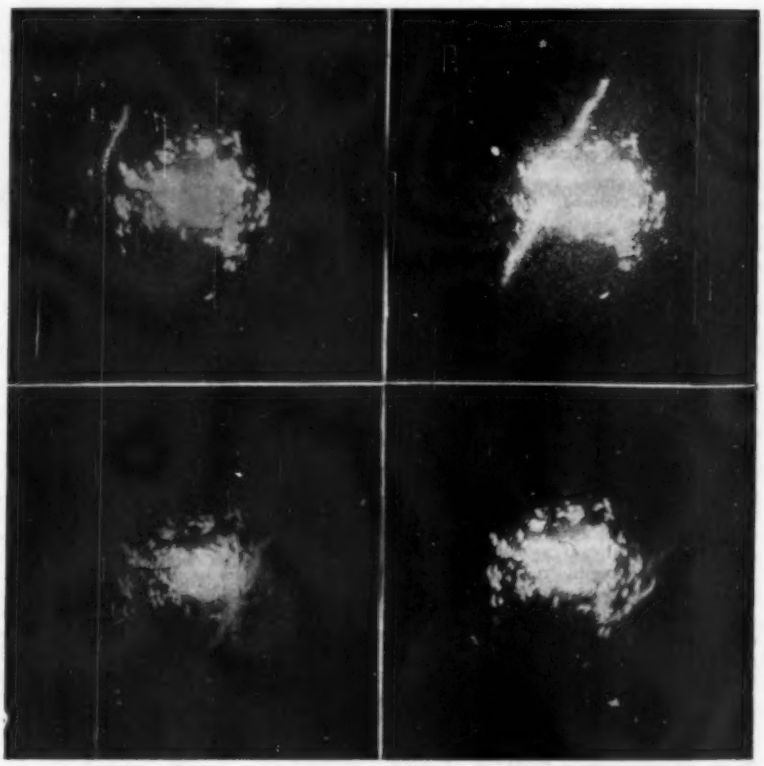

Fig. 4

Fig. 5

UNIVERSITY TRAINING OF ZOOLOGISTS

At a recent meeting in the rooms of the Zoological Society of London, the Association of British Zoologists held a discussion on the training of zoologists in the university, giving an opportunity to discuss the address which its president, Prof. H. Graham Cannon, had delivered when presiding over Section D of the British Association at Brighton last September. A large attendance of members pointed to the interest which this subject clearly has for zoologists at the present time.

The discussion was begun by Prof. D. M. S. Watson, who outlined the historical development of courses of zoology in London since they were first begun by Grant at University College in 1828. During the second half of last century, there took place the gradual establishment of the 'type' system, largely due to the work of Huxley at the Royal School of Mines and the Normal School of Science, and to that of Ray Lankester at University College; and this has survived to the present day as the basic plan upon which courses for degrees in zoology are built. As Prof. Cannon had pointed out in his address at Brighton, there was in the nineteen-twenties a general revolt against the dominating position of comparative anatomy in zoological education, and Prof. A. C. Hardy illustrated from the arrangement of courses in the Department of Zoology at Oxford how much time had now to be devoted to other parts of the subject. During the period 1943–45, 71 per cent of the lectures were allotted to a systematic treatment of the various groups of the animal kingdom, and the remaining 29 per cent to such general topics as ecology and the distribution of animals, genetics, evolution, physiology, embryology, cytology and histology. For the years 1946–48, the figures were markedly different—45 per cent only of lectures were devoted to a morphological treatment of groups; another 45 per cent to the general topics mentioned above, while the remaining 10 per cent went to a course on the history of zoology and to discussion of research topics, a weekly debate on controversial subjects. It seems doubtful, he said, whether the treatment of groups can be profitably or desirably reduced from this, as an understanding of their anatomy and relationships is necessary for the proper treatment of the more general part of the course.

Prof. Hardy emphasized that a course on zoology such as this is essential for the training of professional zoologists: for the general education of the university student reading other subjects, he was prepared to agree with Prof. S. Mangham, who addressed the Association on the recent memorandum prepared by the Association of Scientific Workers on the teaching of biology in universities. This memorandum proposes what is, in effect, the disappearance of separate university departments and courses of botany and zoology, and their replacement by a single integrated department and course of biology, on the ground that world conditions emphasize the need for a new approach to social and food problems, and that this could be well achieved through biology. A biological training, too, would produce not only good technicians but also good citizens, and so could well become a regular part of the curriculum for arts as well as for all kinds of science degrees. So far as the content of the courses was concerned, there was suggested the same kind of distribution of emphasis as indicated by Prof. Hardy (and which later discussion showed was, in fact, general throughout the universities)—a reduction in the teaching of evolutionary morphology, the time thus gained being used to give a more generous treatment of ecology, genetics, physiology, parasitology, human biology and the history of science.

Mr. H. W. Parker, speaking on the needs of the museums, emphasized that they require *educated* zoologists. The fields of knowledge needed in a museum zoologist's career would appear to be essentially compatible with a good general education, and no radical changes in the present zoological courses are called for, though changes of emphasis and timing might be beneficial. For example, natural history, being ill suited to laboratory methods, receives insufficient attention, and taxonomy is out of fashion now that the pertinent question is "How does evolution take place?" rather than "Has it taken place?" Yet, although geneticists and others may show how evolution can take place, the taxonomist can show how it has done so, or is doing so now. Greater taxonomic training would also lead to greater appreciation of the vast range and complexity of animate Nature, a matter which the 'type' system under-emphasizes. Museums must obtain recruits with knowledge suitable for developing new lines of attack: the scant attention by taxonomists to myology, compared with osteology, Mr. Parker said, reflects the different emphases on these two subjects in the universities, and the preponderant attention to marine zoology in most courses has repercussions in the museums. For the proper understanding of the relationships of recent animals, knowledge of the environmental conditions of the immediate past is essential, and this calls for acquaintanceship with geophysics and climatology. Finally, since abiding interests develop more readily in familiar than in unfamiliar fields, Mr. Parker pressed for greater collaboration and for the encouragement of students to visit and actually work in the museums.

RELATION OF A CLOVER JUICE FACTOR CAUSING PARALYSIS OF SMOOTH MUSCLE TO BLOAT IN RUMINANTS

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Ferguson[1] observed that whereas the juices of the most prevalent pasture grasses in Great Britain had little effect on the isolated rabbit intestine, those from certain legumes (for example, clover, lucerne) caused relaxation and paralysis. He excluded the possibility of certain inorganic ions, protein and alkaloid components from being responsible for this phenomenon. The importance of this finding in problems associated with the 'pasture-grazing animal' interrelationships is apparent.

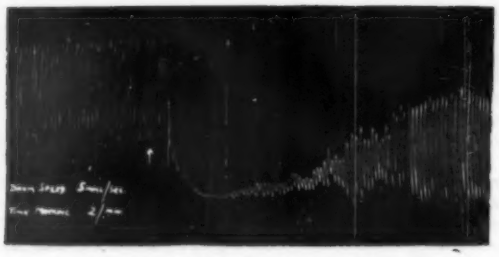

Fig. 1. Typical tracing of rabbit intestine treated with clover juice (2 ml. added to the Tyrode bath of capacity 50 ml.). Similar results obtained with known cytochrome poisons, see text

The cause of bloat, fog-fever, and ruminal atony in cattle and sheep, together with tympanitic colic and grass-sickness in horses, has not yet been established, although a particular pasture environment is usually incriminated. In bloat[2], it is believed that there is an inhibition of the eructation reflex associated with ruminal stasis; the animal being unable to belch cannot void the gases produced in the paunch as a result of fermentation.

Working with the leaf juice of a white clover, we have shown that one of the factors responsible for the effect on the rabbit intestine is hydrocyanic acid. The evidence leading to this conclusion is as follows:

(1) The principle is absent from the residue of either the intact leaves or crude juice after drying at 100° C. in a well-ventilated oven.

(2) Separation of the crude juice into acid, neutral and basic fractions shows that the activity is concentrated in the ether-soluble acid fraction.

(3) Acidified clover juice was steam-distilled, and the distillate collected into ice-cold alkaline Tyrode solution. The distillate possessed the whole of the activity of the juice when tested on the rabbit intestine. It also gave all the chemical tests for a weak solution of hydrocyanic acid. The same acidified clover juice, treated similarly with respect to temperature, in a sealed tube, showed comparable activity with the original, after cooling and neutralization, but in an open tube had lost all activity. This illustrates the volatility of the factor, which caused erratic results in its concentration, until steps were taken to counter it.

(4) Crude clover juice, and a solution of hydrocyanic acid of the same CN′ concentration (estimated by the method of van der Walt[3]), produced almost identical responses on the isolated rabbit intestine (Fig. 1).

Several substances, both synthetic and of natural origin, were tried for their action on the isolated rabbit intestine; the well-known poisons of the cytochrome system all produce a response similar to that shown in Fig. 1, namely, for small doses, relaxation, and diminution of amplitude, with subsequent recovery, but with increased dosage, irreversible paralysis in the relaxed state. The necessary concentrations differ widely: for example, sodium cyanide (1/100,000); sodium sulphide (1/2,000); sodium azide (1/2,000). Hydroxylamine (1/5,000) has a similar effect. Hydrotropic substances like sodium desoxycholate, and sodium taurocholate (1/5,000) and surface-wetting agents (for example, the detergents 'Cetavlon', 'Teepol') also possess a well-marked relaxing effect leading in some cases to paralysis. Saponin (1/5,000) paralyses the rabbit intestine in the contracted state.

It is known that some pasture plants, especially legumes, may contain cyanogenetic glucosides (*Trifolium repens* contains lotaustralin and linamarin[4] which produce hydrocyanic acid by hydrolysis with the appropriate enzyme. Again, hydroxylamine has been postulated as an intermediate in nitrogen metabolism by plants and bacteria. The analysis of rumen gases shows 0·1 per cent hydrogen sulphide to be a fairly normal figure, while Dougherty[5] reports the presence of carbon monoxide in concentrations up to 0·17 per cent. Certain plants, especially legumes, are rich in saponin-like substances.

We have already shown that one litre of clover juice (equivalent to about 5 lb. fresh clover) introduced directly into the rumen of a sheep paralysed its movements immediately. After some time, however, the animal showed general symptoms of acute poisoning, namely, dyspnœa, dilatation of the pupils, and finally succumbed in a tetanic convulsion 2 hr. after administration of the juice. The post-mortem findings were consistent with poisoning by hydrocyanic acid. Estimation showed 200 mgm. hydrocyanic acid per litre in the crude clover juice, which is double the lethal dose[1] for sheep of this size (Welsh Mountain, wt. 100 lb.). During the first 90 min., no ruminal movements were recorded; towards the end they were re-appearing again spasmodically but with diminished force (Fig. 2).

In an attempt to produce bloat in the field, three two-year-old Welsh Black cattle (a bullock and two heifers), starved for 12 hr., were turned to graze a white clover pasture. The three animals grazed the clover avidly for 15 min.; the two heifers then stopped, stood listlessly for a while, and then wandered and grazed rough herbage other than the clover, which they deliberately avoided. The bullock persisted with the clover grazing for a further 5-min. period, and then behaved as the heifers had done. Within a period of 30 min. the bullock showed definite

Fig. 2. *A*: No rumen activity. Drum speed, 5 mm./min.; time marker, 10 per min. *X*: Point of introduction of clover juice (1 litre). *B*: Tracing after addition of the juice. *C*: One hour after dosing, showing rapid respiratory movements and the re-appearance of spasmodic rumen contractions (arrows). *D*: Denotes a marked increase in pressure, when sheep was in a convulsive state

symptoms of distress (respiration 95 per min., pulse 120 per min.) and was slightly blown; the heifers, although full in the flank, were neither blown nor showing signs of discomfort. Blood samples taken at this stage were analysed for hydrocyanic acid content; the bullock's blood contained 0·1 mgm. hydrocyanic acid per 100 ml. blood, while the heifers' had 0·04 mgm. per 100 ml. blood.

The possible role of hydrocyanic acid in the etiology of acute bloat in sheep has been considered before by Clark and Quin[7], but they prefer the 'saponin foam theory' of its pathogenesis (see also Clark[8]).

It seems probable to us that in a complex syndrome like bloat several factors may operate; a satisfactory theory of the cause must not only account for the sequence of symptoms in the animal, but must also explain observations of agriculturists on predisposing environmental conditions. We believe that our findings are significant in this connexion.

We wish to acknowledge our grateful thanks to the Welsh Plant Breeding Station for providing facilities in the field.

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DETERMINATION OF ABSOLUTE INTENSITIES OF X-RAY REFLEXIONS FROM RELATIVE INTENSITY DATA

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RECENTLY, owing to the advent of various methods[1] of direct determination of phase angles of Bragg reflexions from a crystal, a convenient method of determination of absolute intensities of Bragg reflexions seems urgently needed[2]. In 1942 I proposed a simple method of determination of absolute from relative intensities[3], which has since been made rigorous and so should be reliable in general cases if used properly. Accordingly, I present here the final result of the method, which is applicable to practical cases immediately.

Suppose we have a crystal containing t atoms in the unit cell, the number of shell electrons of the ith atom being Z_i. Let the relative intensities of reflexions for the crystal at room temperature be denoted by $I'(hkl)$ for hkl and $I'(000)$ for 000. We have

$$|F(hkl)|^2 = \frac{F^2(000)}{I'(000)} I'(hkl). \qquad (1)$$

We see that if we can determine $I'(000)$ we can deduce $|F(hkl)|^2$ from $I'(hkl)$, for we have the known $F(000) = \sum_{i=1}^{t} Z_i$. Let us introduce

$$\bar{f}(hkl) = \sum_{i=1}^{t} f_i(hkl) \Big/ \sum_{i=1}^{t} Z_i, \qquad (2)$$

where $f_i(hkl)$ is the atomic structure factor at room temperature of the ith atom in the cell. If only $f_i(hkl)$ for atoms at rest are available, such as those obtained from James and Brindley's table, suitable temperature correction must be made in order to obtain the room temperature value of $f_i(hkl)$. We further form the sum $\sum_{i=1}^{t} Z_i^2$. Then from the theory of a new X-ray synthesis developed by me, it can be shown that:

$$I'(000) = F^2(000) \frac{\Sigma' U_{n_1 h} U_{n_2 k} U_{n_3 l} I'(hkl)/\bar{f}^2(hkl)}{\sum_{i=1}^{t} Z_i^2 - U_{n_1 0} U_{n_2 0} U_{n_3 0} \cdot F^2(000)}, \qquad (3)$$

where Σ' denotes the sum $\sum_{h=-\infty}^{\infty} \sum_{k=-\infty}^{\infty} \sum_{l=-\infty}^{\infty}$, excluding the term of $h = k = l = 0$. U_{nh} are known functions of n and h, the numerical values of which are negligibly small for $h > n/2$; $U_{n\bar{h}} = U_{nh}$ when $\bar{h} = -h$. Thus, if the maximum h, k, l of our available set of $I'(hkl)$ are h_M, k_M, l_M, we may choose $n_1 \doteq 2h_M$, $n_2 \doteq 2k_M$, $n_3 \doteq 2l_M$. The values of U_{nh} for some values of n and h are given below:

$U_{nh} \times 10^4$

n / $\pm h$	48	44	40	36	32	28	24	20	16	12
0	334	364	400	443	498	568	660	790	981	1297
1	325	354	388	430	481	547	633	751	920	1187
2	315	341	371	409	455	511	584	679	809	989
3	303	328	357	391	433	484	547	626	729	848
4	294	316	342	372	407	449	499	557	617	646
5	282	303	327	354	386	421	462	505	540	528
6	272	291	311	334	360	387	414	433	422	176
7	256	278	296	316	338	359	377	385	360	
8	251	265	280	296	312	324	328	308	131	
9	239	253	266	278	290	297	294	272		
10	230	240	250	258	263	261	240	104		
11	218	227	235	240	242	235	216			
12	209	215	219	220	215	196	87			
13	198	202	204	203	196	181				
14	187	189	189	181	164	73				
15	177	177	174	167	155					
16	166	164	157	142	64					
17	156	152	145	135						
18	144	138	124	57						
19	135	128	120							
20	122	110	51							
21	115	106								
22	99	46								
23	98									
24	42									
ΣU_{nh}		0·9998		1·0010		1·0016		1·0022		1·0037

The last row gives the sum $\sum_{-h_M/2}^{h_M/2} U_{nh}$ for $n = 48$, 40, 32, 24, 16. Apparently all the sums differ from the theoretical limit $\sum_{h=-\infty}^{\infty} U_{nh} = 1$ only by fractions of 1 per cent, indicating the rapidity of convergence of the infinite series.

The accuracy of $I'(000)$ deduced from (3) depends essentially upon the following four factors:

(1) The accuracy of the observed $I'(hkl)$.

(2) The order of approximation of the equation

$$f_i(hkl) = Z_i \cdot \bar{f}(hkl), \qquad (4)$$

which forms the basis of equation (2). The error introduced by the failure of equation (4) is usually not very serious.

(3) The proper correction of the temperature effect in $f_i(hkl)$. If we actually do a suitable experiment to correct this effect, the error introduced is, of course, limited. Otherwise we have to correct the effect with reference to similar crystals of known structures, and

the error resulting in $I'(000)$ may be very large. This uncertain correction of the temperature effect constitutes the chief source of errors in the value deduced for $I'(000)$.

(4) The correct choice of n_1, n_2, n_3. The strict condition is

$$d_{ss} \geqslant \frac{1{\cdot}2a}{n_1}, \frac{1{\cdot}2b}{n_2}, \frac{1{\cdot}2c}{n_3},$$

where d_{ss} denotes the shortest interatomic distance between any two atoms in contact in the crystal. Because this condition is rather too strict to be satisfied easily, let us introduce a much more approximate condition,

$$d_a \geqslant 1{\cdot}2\left\{\left(\frac{a}{n_1}\right)^2+\left(\frac{b}{n_2}\right)^2+\frac{2ab}{n_1n_2}\,|\cos\gamma|\right\}^{1/2},$$
$$1{\cdot}2\left\{\left(\frac{b}{n_2}\right)^2+\left(\frac{c}{n_3}\right)^2+\frac{2bc}{n_2n_3}\,|\cos\alpha|\right\}^{1/2},$$
$$1{\cdot}2\left\{\left(\frac{a}{n_1}\right)^2+\left(\frac{c}{n_3}\right)^2+\frac{2ac}{n_1n_3}\,|\cos\beta|\right\}^{1/2},$$

where d_a denotes the average interatomic distance between any two contact atoms in the crystal: d_a can be roughly estimated from the nature of the atoms contained. In case the structure contains a number of very heavy small atoms, their effect on $I'(000)$ can be estimated.

When all of the foregoing four points have been provided for, it is believed that the error in $I'(000)$ would fall in the range of 5–20 per cent in the usual cases.

To illustrate the use of (3), let us first take a crystal consisting of only one atom at the origin in the unit cell, the number of electrons in the shell of the atom being Z and the atomic structure factor, $f(hkl)$. Then $F(hkl) = f(hkl) = Z\bar{f}(hkl)$. $F^2(000) = Z^2$. If we assume $I'(hkl) = F^2(hkl)$, we have $I'(hkl)/\bar{f}^2(hkl) = Z^2$. Substituting these values in (3) we obtain

$$I'(000) = Z^2\,\frac{\left(\sum_{h=-\infty}^{\infty} U_{n_1h}\right)\left(\sum_{k=-\infty}^{\infty} U_{n_2k}\right)\left(\sum_{l=-\infty}^{\infty} U_{n_3l}\right) - U_{n_1o}U_{n_2o}U_{n_3o}}{1-U_{n_1o}U_{n_2o}U_{n_3o}}.$$

Using U_{nh} given in the table, with $n_1 = 48$, $n_2 = 32$, $n_3 = 16$, we obtain $I'(000) = 1{\cdot}0051Z^2$, which differs from the assumed $I'(000) = F^2(000) = Z^2$ only by 0·51 per cent. The choice of U_{nh} of any other n_1, n_2, n_3 will give similar results.

Let us next illustrate the method by studying a real crystal, say, *para*dinitrobenzene, the structure of which was determined carefully by James, King and Horrocks[4], who made the determination on the basis of intensities of reflexions $hk0$, $h0l$ and $0kl$. Strictly speaking, we should determine $I'(000)$ from equation (3), based on the relative intensities of the whole set of reflexions hkl. But in the case of the present structure, as we know already from James, King and Horrocks' paper that there is no overlapping of atoms directly upon each other in the projection of the structure in direction b to the ac plane (see ref. 4, Fig. 3), a study of the relative intensities of reflexions $h0l$ is sufficient for our purpose of illustration. Then let us take their observed $F^2(h0l)$ directly as our $I'(h0l)$ and take Robertson's f-values[5] directly as our $\bar{f}(h0l)$. Since no further temperature correction has been made, the values of $\bar{f}(h0l)$ so obtained are under-corrected for the temperature effect as revealed from my studies of the same structure. But we may deliberately use such rough values of $\bar{f}(hkl)$ in order to see if $I'(000)$ so deduced still proves reliable. The structure has

$$F^2(000) = 164^2\,,\ \sum_{i=1}^{t} Z_i^2 = 1140$$

when the contribution of the hydrogen atoms is neglected. $h_M = 13$ such as in $h0l = 13\ 0\ 1$, and $l_M = 7$ such as in $h0l = 1\ 0\ 7$. Accordingly, we take $n_1 = 24$, $n_2 = 12$. The two-dimensional equation for $I'(000)$ is given by

$$I'(000) = F^2(000)\,\frac{\Sigma' U_{n_1h}\,U_{n_2l}\,I'(h0l)/\bar{f}^2(h0l)}{\sum_{i=1}^{t} Z_i^2 - U_{n_1o}\,U_{n_2o}\,F^2(000)}. \qquad (3a)$$

where Σ' denotes $\sum_{h=-\infty}^{\infty}\ \sum_{l=-\infty}^{\infty}$, excluding the term with $h = l = 0$. Substituting in (3a) the appropriate U_{nh} from the table and the other quantities mentioned above, we obtain $I'(000) = 0{\cdot}85F^2(000)$, differing from the assumed $I'(000) = F^2(000)$ by 15 per cent; an acceptable error obtained by deliberately choosing rather rough values of $\bar{f}(hkl)$.

Details of this work, including the method of correcting for the effect of small heavy atoms, will be presented elsewhere.

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FRACTURE OF SOLIDS

A CONFERENCE on "The Fracture of Solids" was held by the British Rheologists' Club on October 29. Prof. N. F. Mott, recently elected president of the Club, opened the conference by pointing out that, quite apart from its practical importance, fracture was the most interesting property of solids to the theoreticians because it is the least understood property, no progress having been made beyond the Griffith crack-theory of 1924. It is not known how cracks exist nor what causes them; experimental work has made clear what happens during fracture, but not how it occurs.

Dr. C. F. Tipper then presented a paper describing some beautiful experimental work on the subject of fracture in mild steel. She divided fracture into three types: the first corresponds to a parting along a shear plane; the second along two intersecting planes, giving a wedge-shaped fracture; and the third along a plane quite different from the shear plane, often at right angles to the principal tensile stress. Iron and mild steel show all three types of fracture, and it is possible to have all in the same test-piece, even in adjacent crystals. The amount of energy absorbed in fracture depends on how much of each type goes to make up the total fracture. The third type, which is generally brittle, can always be

traced back to a notch, and so in laboratory experiments a notch is inserted deliberately. The metal at the base of the notch can be regarded as a tensile specimen of very short gauge-length eccentrically loaded, and the natural crack is thus started at 90° to the direction of loading. In a very ductile material the crack eventually turns to 45°, and in a brittle material its mean path remains perpendicular to the direction of loading.

Dr. Tipper showed the importance of inclusions in the metal, separation occurring around such inclusions at an early stage in the deformation and forming a pattern of holes near the actual fracture. This separation divides the material into a bundle of independent test-pieces. Inclusions can also stop a fracture when they lie at right angles to the direction of propagation, as they then relieve the stress. Fracture is thus very strongly structure-sensitive. The main conclusion of this work is that fracture begins piecemeal at different places in the material, a fact confirmed by the work of Bridgman, in which a high hydrostatic pressure is found to increase ductility. In the processes of rolling and wire drawing, cracks are not allowed to open, and this is why such large strains are possible without fracture.

Prof. H. Moore then spoke on the fracture of glass. He pointed out that the phenomena of fracture should be explainable in terms of structure, but that a theory of structure could not be based on a study of fracture alone, as had been attempted by some workers. Vitreous silica consists of SiO_4 tetrahedra linked by the oxygens at the corners, each tetrahedron having four linkages at 120° to each other. In silicate glasses the introduction of an alkali such as sodium oxide breaks these linkages, but divalent oxides, such as lime, can provide bridges between tetrahedra which have become temporarily separated. On the molecular scale the structure is irregular, but on any larger scale it is isotropic, giving rise to the familiar conchoidal type of fracture. The structure has no slip planes, and if strained so that one linkage is broken, the other neighbouring linkages, inclined at 120° to the broken link, are also disrupted. Glass has therefore no ductility, its yield strength being equal to its breaking strength.

As with metals, the strength calculated from the structure is many thousand times greater than the observed strength. Fine freshly drawn glass fibres are, however, many hundred times stronger than massive glass; but the strength diminishes extremely rapidly in moist air. The weakness of glass is in its surface, and can be accounted for by the Griffith surface-flaw theory in combination with the effects produced by adsorbed moisture. Moisture rapidly alters the surface layers and can, in fact, cause the whole of the skin to peel off. Under continuous steady loading in moist air, glass is weaker than under momentary loading, due to progressive deterioration of the side-surfaces of the flaws opened by the deformation. This is not a fatigue effect similar to the fatigue effects in metals; under continually reversed loading, glass shows no sign of fatigue because its structure is not affected by the strain reversals.

Mr. H. Warburton Hall then spoke of the fracture of plastics. The understanding of fracture is likely to be easier in the case of the thermo-plastic types than in the case of the more heterogeneous thermosetting plastics. A large amount of experimental data on the mechanical behaviour of the former have been obtained, including investigations into the dependence of tensile strength on such fundamental properties as molecular weight, molecular weight distribution, chemical structure of the polymer, crystallinity, molecular orientation, time of stressing, etc. Haward found that the time to fail of cellulose acetate under constant stress was independent of any rest or deformation-recovery periods allowed during the test, and depended only on the total time under stress; thus in this case all stressing does irreparable damage.

Mr. Hall described investigations on methyl methacrylate at the Royal Aircraft Establishment which had confirmed that tensile stress combined with solvent vapour absorption caused crazing, and that crazing consists of fractures in the surface of the material. The fractures are local tensile failures which under continued stressing lead to bulk failure. There are, however, two main conditions of the material which influence its tendency to craze. (1) Condition direct from the casting process: the material then contains residual solvent (namely, monomer) and elastic strains. If either the solvent content or the condition of elastic strain is increased, crazing will result. In this case solvent vapour causes random pattern crazing. (2) Heat-treated condition: in this case the residual monomer is fully polymerized, the elastic strains are eliminated and *both* solvent vapour and tensile stress are needed to cause crazing. The craze lines, however, are now always perpendicular to the direction of the tensile stress.

A large number of liquids have been investigated, and all those which swell or dissolve the polymer tend to cause crazing.

Finally, Mr. Hall mentioned that the detailed investigations by E. W. Russell on the solvent-vapour absorption characteristics of methyl methacrylate had indicated the possible mechanism of crazing. His results show that films of the polymer stretched at high temperatures and then cooled to normal temperatures while stretched, absorb vapour more rapidly than films not so stretched. It is likely, therefore, that crazing is due to non-uniform vapour absorption which causes stress relaxation at one point, resulting in stress concentration at others, until local rupture takes place, which appears as crazing.

Dr. E. Orowan spoke on the theory of fracture, pointing out that the Griffith crack-propagation theory gave a very good account of fracture phenomena in glasses. According to the Griffith formula, the strength should be proportional to the square root of the surface energy; according to experiments by Obreimow and himself, the surface energy of mica is about twelve times higher in vacuum than in air, and, if this ratio is assumed for glasses, the strength in vacuum should be about $\sqrt{12}$ (or 3·5) times higher than the strength in air. The same ratio should exist between the fracture stresses for very short and very long durations of the test, because the air cannot penetrate to the tip of the crack in the first case; moreover, there should be no difference between long-time strength and short-time strength if the experiment is carried out in vacuum. All these conclusions have been confirmed experimentally. Dr. Orowan pointed out the geometrical meaning of the two-dimensional fracture criterion put forward by Griffith in 1924. If the two principal stresses P and Q are plotted as ordinates, the criterion of fracture is represented in the plane of P—Q by a curve consisting of a parabola, with vertex at the origin and axes directed at 45° into the negative quadrant, and

also of the vertical and horizontal tangents to this parabola. He found that this fracture criterion agrees very well with recent experiments of P. W. Bridgman on the fracture of brittle materials under hydrostatic pressures.

In the discussion Dr. R. N. Haward pointed out that over a time-range of $10^9 : 1$, Preston had found that the relation between $\log T$ and $1/S$ (S is breaking strength) is linear, and he doubted whether this would bend over just at the limits which were set by the experimental conditions to give Dr. Orowan's factor of 3·5.

Mr. R. L. Brown spoke on the fracture of coal, where one is interested in the size distribution of the fragmented pieces and also the variation of strength of these pieces with size. He showed that, when the size distribution of broken coal deviates from the natural distribution, some of the particles can be relatively weak, so that further rough handling of the consignment of coal tends to bring them back to the natural size-distribution. This theoretical investigation is confirmed by experimental evidence on one coal. Mr. Brown pointed out that, in the case of coal, one had to think of millions of particles, and it was not possible to consider an individual test-specimen; accordingly, the strength measurements were made by a shatter test, in which the coal was dropped several feet on to an iron plate, and the strength calculated from the resulting degradation.

Dr. W. W. Barkas spoke on the fracture of wood, the oldest structural material. Under tension, wood fractures by the oxygen groups, and the tensile strength accordingly only goes down by 25 per cent when the wood is wet. On the other hand, under compression, wood fractures by shear on the hydroxyl groups, and the compression strength goes down very much more when the wood is wet. In the manufacture of bent-wood furniture, the bending is therefore by kinking on the inside, the outside remaining unbroken. The work due to fracture is almost independent of the moisture content.

M. W. THRING

AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES

IN discussing recent proposals for an Institute of Biology in Great Britain (see *Nature*, December 4, p. 878), reference was made to the recent establishment and activities of the American Institute of Biological Sciences (A.I.B.S.).

During the Second World War, American biologists became acutely conscious of the fact that the importance of biology and the value of the contributions which biologists were making toward the war effort were little understood by the general public and by Government circles in the United States. As a result of this feeling, a movement developed which finally culminated in the establishment of the American Institute of Biological Sciences. After an informal meeting of a few biologists in Cleveland during September 1944 under the leadership of Prof. E. G. Butler, of Princeton University, an open meeting was called in St. Louis in March 1946 under the sponsorship of the Union of American Biological Societies, the American Biological Society, and the American Society of Naturalists. Dr. Detlev W. Bronk put forward the idea of a biological institute, and those present urged that the informal group continue its deliberations. As a result, this group presented plans to the Division of Biology and Agriculture of the National Research Council for the formation of an Institute. An advisory committee, with Prof. H. B. Steinbach as executive secretary, drew up a proposed constitution and by-laws. An organising board, consisting of one representative from each biological society affiliated with the Division of Biology and Agriculture of the National Research Council, met on April 11, 1947, adopted the constitution and by-laws, and presented the plans to the several societies for ratification. It was agreed that when ten societies had given their adherence to the Institute it would be formally organised. This was accomplished by January 1948, and on February 20, 1948, representatives of the adhering societies met in Washington and formally constituted the American Institute of Biological Sciences.

The purpose of the Institute as expressed in its constitution is "the advancement of the biological sciences and their applications to human welfare. To serve these purposes, the Institute will, among other things, assist societies and other organisations in such matters of common concern as can be dealt with most effectively by united action; co-operate with local, national and international organisations concerned with the biological sciences; promote unity and effectiveness of effort among all those who are devoting themselves to the biological sciences and their applications by research, teaching, or by study; and foster the relations of the biological sciences to other sciences, to the arts and industries, and to the public good."

The Institute is set up within the framework of the National Research Council. Several categories of membership are provided: (1) member organisations—societies and other non-profit organisations having a national field of operation in the biological sciences; (2) individual members; (3) affiliates—societies wishing to support the Institute in a less active way than through full membership; (4) associates—commercial or other organisations. The Institute is managed by a governing board, consisting of one representative of each member organisation and four representatives of the National Research Council, with a smaller executive committee. The executive officer is designated as the executive secretary. Member societies make annual grants to the Institute in proportion to their membership. Affiliated societies pay 100 dollars or more, and associates pay a minimum of 200 dollars per year. Headquarters of the Institute are in the National Academy of Sciences, National Research Council Building, 2101 Constitution Avenue, Washington, D.C. The chairman of the board of governors is Dr. Ralph E. Cleland; the vice-chairman, Dr. E. G. Butler; and the executive secretary, Dr. Milton O. Lee. Up to the present, fifteen societies have become full members and two societies affiliated members; they are as follow: American Association of Anatomists, American Physiological Society, American Phytopathological Society, American Society for Horticultural Science, American Society of Ichthyologists and Herpetologists, American Society of Parasitologists, American Society of Plant Physiologists, American Society of Zoologists, Botanical Society of America, Ecological Society of America, Genetics Society of America, Mycological Society of America, Poultry Science Association, Society for the Study of Development and Growth, Society of American Bacteriologists, American Society of Mammalogists, Society of American Foresters.

Since its creation in February 1948, the Institute has undertaken a number of projects. It organised the annual meetings for eleven biological societies which met in Washington during September 1948. It appointed a Committee on Selective Service, which became the Panel of Biology of a committee advisory to General Hershey, director of selective service. This panel has worked with similar panels in other fields to develop a comprehensive plan for selective service which will utilize scientific and technical manpower to the greatest advantage. Recognition and utilization of this Committee marks a definite step forward for biology, this being the first time that biology has been officially recognized in connexion with man-power problems in the United States. The Institute has established a roster of individual biologists who are members of the constituent societies; more than 10,000 individuals are at present listed. A study of publication costs and of possible ways of aiding biological publication is now going on. The Institute is endeavouring to secure increased financial assistance for the American Type Culture Collection, and is developing a plan for a broader and more secure foundation of support for this essential organisation. The publication of a hand-book of biological data is being initiated. The Institute is working with the American Association for the Advancement of Science in the organisation of the meetings of the various biological societies which are to be held in New York during December 1949, and is studying the whole question as to times and meeting-places for future joint meetings of biological societies. A number of other projects are planned for the immediate future and will be undertaken as soon as possible.

The American Institute of Biological Sciences has thus been able to make a distinct contribution to the progress of biology in the few months of its existence.

TETRAETHYL PYROPHOSPHATE AS AN INSECTICIDE

THE shortage of nicotine for use as an insecticide has stimulated the search for suitable substitutes. One of the organic phosphorus insecticides called hexaethyltetraphosphate (H.E.T.P.) seemed to fulfil many of the requirements; but more recent research has indicated that tetraethyl pyrophosphate (T.E.P.P.) is responsible for at least the major part of the insecticidal activity of hexaethyltetraphosphate, and that an insecticide containing a high percentage of this material was desirable. Messrs. Albright and Wilson have now available an insecticide containing 40 per cent tetraethyl pyrophosphate as compared with the 20 per cent contained in so-called hexaethyltetraphosphate. They are issuing a brochure describing the properties of this material and its use as an insecticide.

Tetraethyl pyrophosphate is a mobile liquid, miscible with water and most common organic solvents; it is not, however, freely miscible with petroleum ether or other paraffin hydrocarbons. In the absence of moisture it is a stable compound, but it hydrolyses rapidly in the presence of water. It is hygroscopic. It is said to be compatible with a variety of insecticides and fungicides; but it should not be used with alkaline materials. It may be applied as a spray or as an aerosol. In the concentrations used it exhibits very little phytotoxicity. It lacks the fumigant effect of nicotine. Tetraethyl pyrophosphate is very toxic to warm-blooded animals, and the concentrates must be handled with great care. The products of hydrolysis are said to be harmless, and it would appear that no toxic residues should be present forty-eight hours after spraying, although it seems desirable that a safety margin should be allowed.

Its chief use in practice would appear to be for the control of aphids and thrips, although it may be found useful for other pests; for example, it appears to be effective against the active stages of red spider, although it seems to have little or no ovicidal effect. Another organic phosphorus compound, 0.0.-diethyl 0.-*p*-nitrophenyl thiophosphate, is probably at least as effective an insecticide as tetraethyl pyrophosphate against most of the insect species on which it has been tested, and much more effective against some species. It also acts as an ovicide. This compound, therefore, may prove a serious competitor with tetraethyl pyrophosphate, but it has the disadvantage that, not only is it toxic to warm-blooded animals, but also it is a stable compound and therefore liable to leave dangerous residues. In some circumstances, therefore, tetraethyl pyrophosphate may be the preferable insecticide.

C. POTTER

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 7

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5.30 p.m.—"Explorations in Western Mexico" (Kodachrome films with commentary by Dr. Telford H. Work).

INSTITUTION OF ELECTRICAL ENGINEERS, SOUTH MIDLAND CENTRE (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 6 p.m.—Mr. H. E. Dance: "Visual Methods in Engineering Teaching". (To be repeated on Thursday, March 17, at Savoy Place, Victoria Embankment, London, W.C.2, at 5.30 p.m., and on Tuesday, April 5, at the Engineers' Club, Albert Square, Manchester, at 6.15 p.m.)

SOCIETY OF CHEMICAL INDUSTRY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. T. Vickerstaff: "The Physical Chemistry of Dyeing".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND S.E. COUNTIES SECTION (joint meeting with the WOOLWICH POLYTECHNIC SCIENTIFIC SOCIETY, at Woolwich Polytechnic, Woolwich, London, S.E.18), at 7.30 p.m.—Dr. G. E. Turfitt: "Science in Criminal Investigations".

Tuesday, March 8

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Annual General Meeting: at 1.10 p.m.—Colonel B. Ungerson: "Some Deficiencies in Present-day Industrial Psychology".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. Daryll Forde: "The Human Factor behind Food from Africa".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. W. C. Osman Hill: "Man's Relation to the Apes".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. Levland: "The Application of Vacuum to Industrial Chemical Processes": Mr. G. Arrowsmith: "The Production of Vacuum for Industrial Chemical Processes".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. G. Delépine (Lille): "Comparative Stratigraphy of the Carboniferous Marine Formations in N.W. Europe and Mediterranean Area". (Special University Lectures.)* (Further Lecture on March 10.)

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 5.30 p.m.—Dr. J. W. Jackson: "Domesticated Animals from Archæological Sites".*

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. W. Harrison: "The Colour of Fluorescent Lamps".

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Harry Vickers: "South German Cities".

INSTITUTION OF THE RUBBER INDUSTRY, BURTON-ON-TRENT SECTION (at the Education Offices, Guild Street, Burton-on-Trent), at 7 p.m.—Mr. H. Willshaw: "Machinery Requirements for the Rubber Industry".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND S.E. COUNTIES SECTION (joint meeting with the WELWYN GARDEN CITY SCIENTISTS' CLUB, at The Cherry Tree, Welwyn Garden City), at 8 p.m.—Dr. A. Albert: "Drug-Action, Ions and Neutral Molecules".

INSTITUTION OF ELECTRICAL ENGINEERS, CAMBRIDGE RADIO GROUP (at the Cavendish Laboratory, Cambridge), at 8.15 p.m.—Prof. D. R. Hartree: "Electronic Calculating Machines".

Wednesday, March 9

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (joint meeting with the NATIONAL SMOKE ABATEMENT SOCIETY, at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. P. D. Kirkman: "The Efficient Use of Fuel".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir John Forsdyke: "The Functions of a National Museum" (Trueman Wood Lecture). (Further Lectures in the series on Museums will be given on March 23 (Mr. Trenchard Cox: "The Provincial Museum"), March 30 (Mr. Edgar Kaufmann: "Museums and Industrial Design"), April 6 (Mr. A. S. Edwards: "The Local Museum"), April 27 (Dr. Iorwerth C. Peate: "The Folk Museum"), May 11 (Mr. Elias Svedberg: "Museum Display"), and on May 25 (Dr. D. A. Allan: "Museums and Education").)

LINNEAN SOCIETY OF LONDON (at the British Museum (Natural History), Cromwell Road, London, S.W.7), at 3 p.m.—Demonstration: "Zoological Taxonomy after 1758".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 3.30 p.m.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL PANEL of the FOOD GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Annual General Meeting; at 6.30 p.m.—Dr. E. Windle Taylor: "Microbiological Problems in the Production of Pure Water".

SCIENTIFIC FILM ASSOCIATION (in the Lecture Theatre, Wellcome Foundation, 183 Euston Road, London, N.W.1), at 7 p.m.—Miss F. Anthony: "The Organisation of a Research Film Unit".

INSTITUTION OF THE RUBBER INDUSTRY, SOUTHERN SECTION (at the Polygon Hotel, Southampton), at 7.15 p.m.—Mr. H. J. Lanning: "Neoprene".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.30 p.m.—Mr. G. A. R. Foster: "Some Automatic Testing Instruments for the Measurement of the Regularity of Cotton Yarns and Rovings".

Thursday, March 10

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Charles Harington, F.R.S.: "National Institute for Medical Research".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. C. E. Dent: "The Development and Application of Paper Chromatography".* (Further Lecture on March 17.)

LINNEAN SOCIETY OF LONDON (joint meeting with the SYSTEMATICS ASSOCIATION, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Cytology as a Factor in Taxonomy" (to be opened by Dr. W. B. Turrill).

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. G. A. Barnard: "Statistical Inference".

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. W. E. Harper and Mr. H. P. Walker: "Acrylic Plastics in Lighting".

INSTITUTE OF WELDING (joint meeting with the INSTITUTION OF STRUCTURAL ENGINEERS, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. J. T. Phillips and Mr. F. J. Daniels: "Welded Steel Framed Buildings".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the NOTTINGHAM SECTION and the FINE CHEMICALS GROUP, at the Gas Company's Show Room, Parliament Street, Nottingham), at 6.30 p.m.—Mr. J. C. McGowan and Mr. J. F. Grove: "Some Applications of Physical Chemistry to the Study of certain Biologically Active Compounds".

BRITISH ASSOCIATION OF CHEMISTS (at Gas Industries House, 1 Grosvenor Place, London, S.W.1), at 7 p.m.—Dr. Joseph Needham, F.R.S.: "The Work of U.N.E.S.C.O.".*

UNIVERSITY OF LONDON (at Wye College, Wye, Kent).—Sir John Russell, F.R.S.: "Agricultural Research in the 20th Century" (Fellowship Lecture).*

Friday, March 11

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

PHYSICAL SOCIETY (in the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Scientific Papers. (Members of the Colour Group are invited.)

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Discussion on "Polarographic Analysis".

UNIVERSITY OF LONDON (in the Geology Lecture Theatre, Royal School of Mines, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. F. T. Brooks: "The Contribution of the Plant Pathologist to Horticulture".*

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Application of Flux Meters to Experiments on Electric Machines" (to be opened by Prof. E. B. Moullin).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. R. W. L. Gawn: "Cavitation of Screw Propellers".

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (at the College of Technology, Manchester), at 7 p.m.—Mr. G. R. Hinks: "Building the Central Library and Town Hall Extensions, Manchester".

Saturday, March 12

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. J. C. Wood-Mallock: "Solvent Extraction as a Unit Process".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT AGRICULTURAL ECONOMIST in the Department of Agriculture—The Registrar, The University, Leeds 2 (March 10).

SENIOR SCIENTIFIC OFFICER (with a degree in science with first-class honours in botany) and a SENIOR EXPERIMENTAL OFFICER (with at least the H.S.C. in a science subject or equivalent qualification and a good knowledge of crops and crop husbandry), at the Department of Agriculture for Scotland Seed Testing and Plant Registration Station at East Craigs, Corstorphine, Edinburgh—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2434 (March 10).

ASSISTANT EXPERIMENTAL OFFICERS (3, temporary), Food Infestation Control, Department of Agriculture for Scotland—The Secretary, Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.536/48 (March 10).

DEPUTY STATISTICAL OFFICER in the Statistical Section of the Town Clerk's Department—The Town Clerk, Room 30B, Council House, Birmingham 1, endorsed 'Deputy Statistical Officer' (March 11).

LECTURER IN CHEMICAL ENGINEERING—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (March 12).

RESEARCH MANAGER—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx. (March 12).

LECTURER (Grade III) IN CHEMISTRY, with special interest in physical and inorganic chemistry—The Registrar, Queen Mary College, Mile End Road, London, E.1 (March 14).

JUNIOR ASSISTANT PHYSICIST in the Physics Department—The Secretary, Bristol Royal Hospital, General Hospital Branch, Guinea Street, Bristol 1 (March 15).

GEOLOGICAL AND TOPOGRAPHICAL DRAUGHTSMEN in the Department of the Geological Survey of Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (March 15).

LECTURERS (2, Grade II) IN MINING—The Secretary, The University, Birmingham 3 (March 19).

READERSHIP IN THEORETICAL PHYSICS at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 21).

ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY—The Education Officer (H.1/2), County Hall, Westminster Bridge, London, S.E.1 (April 1).

VISITING PROFESSOR OF PLANT PHYSIOLOGY at the Faculty of Science, Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (April 15).

SENIOR TECHNICIAN with histological training for laboratory principally engaged in endocrinological research—Professor of Anatomy, Medical School, Edgbaston, Birmingham 15.

LABORATORY TECHNICIANS—The Regional Blood Transfusion Officer, Bridle Path, York Road, Seacroft, Leeds.

SENIOR TECHNICIAN in the Department of Materia Medica—The Administrative Officer, Medical School, Dundee.

LABORATORY ASSISTANT to help in sorting and mounting entomological material—The Secretary, Department of Entomology and Parasitology, School of Tropical Medicine, Liverpool 1.

PHYSICIST or ENGINEER to develop various special components of the cyclotron, and a VACUUM ENGINEER—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12, endorsed 'Cyclotron'.

EXPERIMENTAL OFFICERS (2) to assist in studies of Bee behaviour—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

RESEARCH PHYSICIST for fundamental research on Atmospheric Physics—Dr. G. B. B. M. Sutherland, Pembroke College, Cambridge.

TECHNICIAN (Grade III) as second Lecture Theatre Assistant in the Department of Physics (Ref. Physics/2), and a TECHNICIAN (Grade IV) in the Department of Geology (Ref. Geology/2)—The Secretary, University College, Gower Street, London, W.C.1, quoting the appropriate Ref.

ENTOMOLOGISTS (2) in the Research Division of the Department of Agriculture and Forests, Sudan Government—The Sudan Agent in London, Wellington House Buckingham Gate, London, S.W.1, endorsed 'Agricultural Entomologist'.

INSPECTOR (Plant Protection) IN THE RESEARCH DIVISION of the Department of Agriculture and Forests, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Plant Protection'.

LECTURER or ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Exeter.

SURVEYORS (experienced and qualified) in the Survey Department of Hong Kong, Malaya, Nigeria, the Gold Coast and Tanganyika—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

PHYSICIST, a CHEMIST, and an ENGINEER, for a new laboratory at Galashiels—The Secretary, Wool Industries Research Association, Torridon, Leeds 6.

FIELD ZOOLOGIST in the Veterinary Department, Kenya, for Tsetse Fly survey and control—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

LECTURER IN GENERAL SCIENCE with particular application to foodstuffs, and a LECTURER IN FOODSTUFFS with experience in nutrition and microbiology—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.